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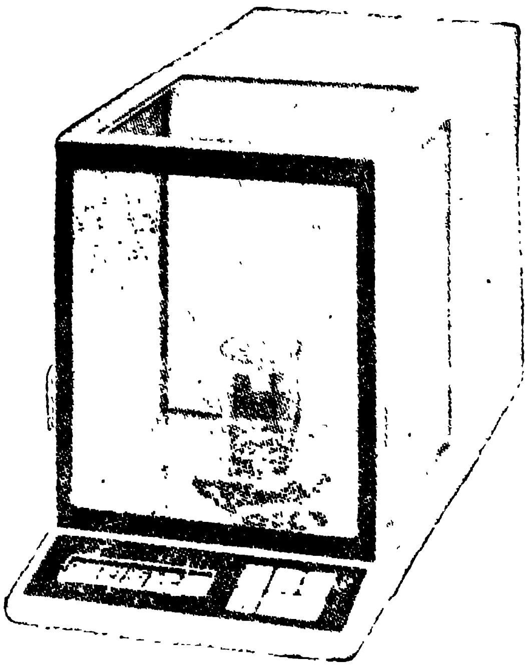

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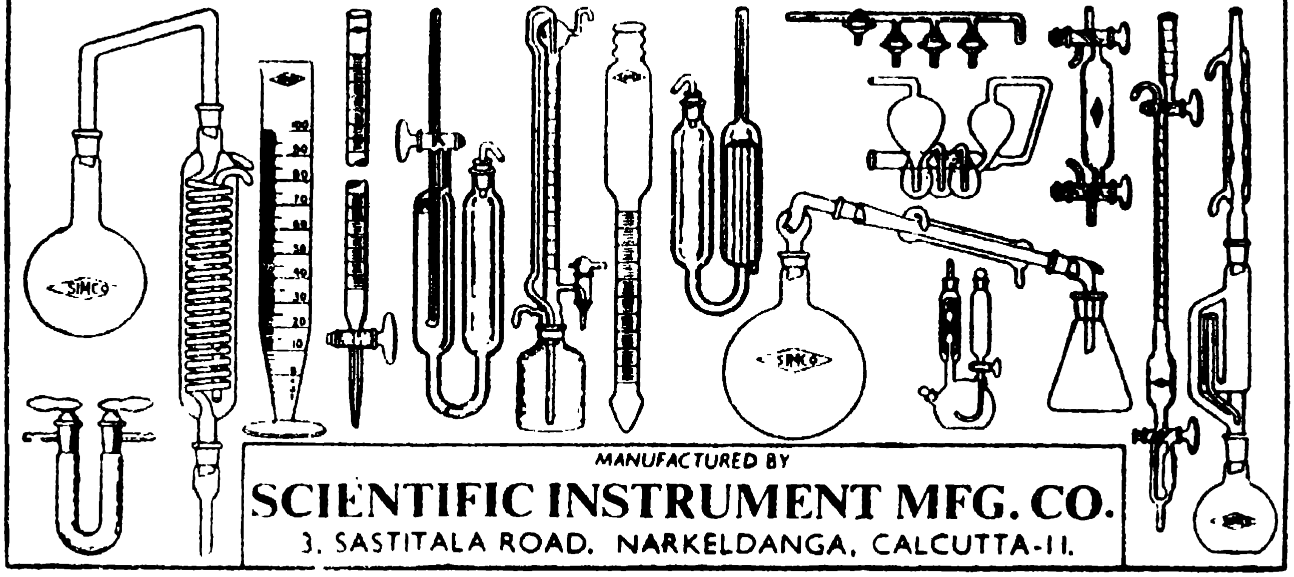

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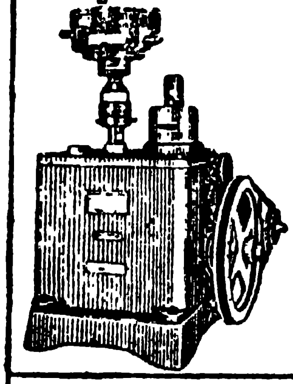

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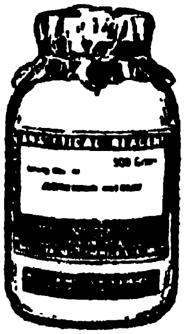

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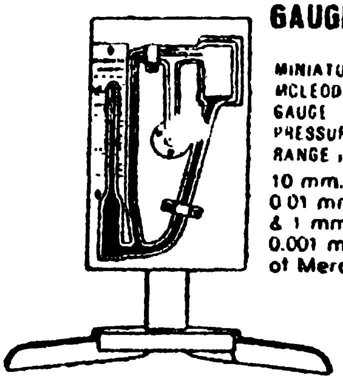

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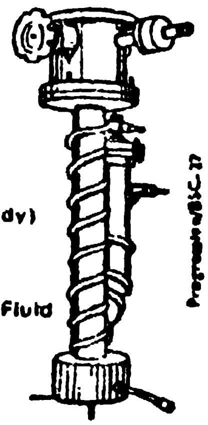

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Foreign	£ 10.00 or U.S. $ 20.00
Single Copy (Inland)	Rs. 7.50
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SCIENCE & CULTURE

January 1989/Volume 55/Number 1

A MONTHLY JOURNAL OF NATURAL & CULTURAL SCIENCES

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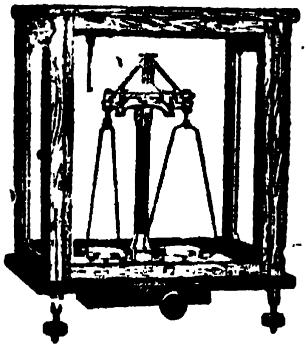

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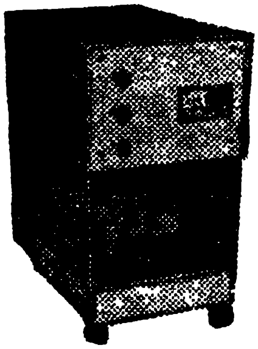

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SCIENCE
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VOLUME 55 □ JANUARY 1989 □ NO. 1

THE INDIAN SCIENCE CONGRESS—A RETROSPECT

THE Indian Science Congress has completed three quarters of a century. It's evolution has kept pace with the cross currents of Indian history.

The birth and growth of this congress reflect two interesting historical developments. One was the in-built contradiction in the planting of Western Science in India with exclusive concern for the fruit and total disregard for the soil and the other was the inevitable conflect of culture. Out of the first rose voices of protest against too much of result oriented research and too little research for the sake of knowledge. Out of the second emerged the Indian struggle to establish an independent scientific tradition. The history of the first thirty years of the Science Congress provide us a dramatic view of the swift and far reaching changes taking place, how quickly the Indians were coming up to displace the westerners, so that when the time came for taking national planning into our own hands we had our scientists, technologists ready for the task. In many ways the Indian Science Congress accelerated the process.

The Indian Science Congress in its eventful life of 75 years has witnessed a most remarkable phase of scientific growth in the country, beginning from the peak of colonial science to the swift take over by the Indians who lost no time in shaping and changing the entire character of the movement. It's history of 75 years can be divided into two almost equal periods—1947 providing, technically speaking the watershed. How the emphasis from the early field sciences shifted to scientific research in a more proper sense of the term can be seen from the very beginning.

The foundation of the Indian Science Congress can be seen as a curious parallel to the formation of the Indian National Congress, which was given a concrete shape by a retired English Civil Servant A. O. Hume. He took the initiative, got the support and co-operation of prominent Indian leaders. The first meeting was presided over by an Indian W. C. Banerjee. Exactly the same thing was repeated in the first Science Congress. The idea mooted by two British Chemists P. S. MacMohen of Canning College, Lucknow and J. L. Simonsen of Presidency College, Madras and with the patronage of the Asiatic Society of Bengal the first Indian Science Congress was presided over by another eminent Indian Sir Asutosh

Mookerjee. The aims of these two organisation also follow more or less a similar pattern. The aims of the Indian National Congress was declared to be promotion of friendly relations between nationalist political workers from different parts of the country, development and consolidation of the feeling of national unity.... formulation of popular demands and their presentation before the Government and most important of all, the training and organisation of public opinion in the country.

The main idea behind the formation of this congress was to provide an outlet," a Safety Valve' to the growing public discontent against the British. But Hume was very soon proved wrong, because, instead of being a peaceful platform for educated Indians, it soon transformed itself into a more vocal and active launching pad for vigourus nationalist movement.

Interestingly enough, the Science Congress also, which began more or less as a club for the British and some Indian scientists, lost no time in changing its colour. After the first two decades the change was evident. But initially they accepted British help because the country's scientific base was not strong enough to stand on its own and they had to count on the Government for help.

As in the case of the Indian National Congress the English participants of the Science Congress did not lack in altrustic concern for India; access to European knowledge also had its uses. But when it came to sharing research with Indians and giving them opportunities for higher research —the Surveys (who were concerned primarily with field sciences) kept their doors closed to the Indian workers. In the 7th Session at Nagpur (1920) P. C. Ray exposed the racial discrimination, the fact that the Great Trigonometrical Survey was entirely manned by Royal Engineers with military rank. "While Europe, America and Japan have taken to the field of science with singular vigour and activity, how does the land lie about us in India? The situation fills our mind with sorrow and shame...."

The "We" here is not the administration who had prided itself in bringing down cholera death in an earlier session. P. C. Ray was speaking for the Indian scientists; he substantiated his arguments with facts, giving a table showing how Indians were being discriminated. The table showed the composition of the then existing scientific services which had very few Indians and a different scale of pay for them. "I do not want to minimise their (the Europeans) achievements. The credit of their work, however, belongs to their own native countries, and the results of their experience are enjoyed by their own countrymen. I shall try to make my point a bit clearer. The Indian lives and moves and has his being in the midst of his own people; the European somehow or other, lives in a world apart, and from his exalted position of aloofness and isolation fails to inspire those who may happen to come into contact with him. Moreover, the European, when he attains the age retires to his own native land, and the accumulated experience gained at the expense of India is lost to the country for good. In a word, the present system arrests Indian intellectual growth and inflicts a cruel wrong on India".

During the first twenty years there is an obvious dominance of British scientists—most of them from the Government service. There were 13 British presidents and seven Indian, the latter being Sir Asutosh Mookerjee, Sir P. C. Ray, Sir R. N. Mookherjee, Sir J. C. Bose, Sir C. V. Raman, M. Visvesvaraya and Shiv Ram Kashyap. From 1933 onwards the Indians seemed to have taken over the organisation, the last British name to appear was during the 25th year, Lord Rutherford was supposed to become, but because of his death Sir James Jeans came to read his address. The only single name of a foreign scientist in the next half century is that of W. D. West who came for the 59th session at Calcutta.

As the Science Congress began to grow in size and importance (enjoying the patronage of the Prime Ministers all along) a spirit of self criticism was evident. The desire to play a more effective role in nation building, a sense of social responsibility and commitment on the part of India's men of Science grew stronger. This found expression in the idea of having a focal theme for each session to high light a specific aspect of science and technology and its role in economic activities. The exercise started in 1976, gathered momentum to the extent that national policies evolved out of the recommendations of the Science Congress. A Task Force was formed to look after the implementation. Increasing interaction with the Government however has cast the individual scientist working in the University in the shadow. The Science Congress has thus come full cycle. From the early days of imperial dominance it emerged as a platfrom for national science. At the present moment it seems to be going back to the apron strings of the government departments. While it is gratifying to find the scientists in more meaningful social roles it is also necessary to see that individual creativity is not stunted in the process. ☐

Santimay Chatterjee
Enakshi Chatterjee

NETAJI SUBHAS CHANDRA BOSE* AND SCIENCE

BALDEV SINGH**

THE idea of studying Netaji Subhas Chandra Bose's attitude to and views on science and science-related matters arose from several references to him in the biography of the eminent scientist Meghnad Saha by Santimay Chatterjee and Enakshi Chatterjee.[1] Saha was a contemporary of Subhas Bose's elder brother Sarat Chandra Bose and a few years senior to him in the Presidency College, Calcutta. Saha was very fond of Subhas Bose[2] and had maintained his acquaintance with him since their college days. In 1922, Bose as a leader of the Bengal Provincial Congress Committee had invited Saha to preside over the Bengal Youth Conference[3] and Saha as scientist had emphasized that "I do not wish to under-rate the concept of sacrifice, but I put power and work above it. Sacrifice often becomes another name for incompetence. The key word of the presence civilization' is science. As I have said earlier, to survive we have to struggle with nature and to win this battle we must have science as a tool........"[4]. Santimay Chatterjee writes that when Bose was elected President of the Indian National Congress in 1938, Saha saw Bose and posed questions as to how Congress was going to solve the country's problems to provide food, housing and clothing to India's millions ? In the absence of a clear-cut answer from Bose, Saha made a proposal for the formation of a National Planning Committee, to which Bose agreed and invited Saha to join a meeting in Octobar 1938. Initially Sir M. Visvesvaraya was asked to be the Chairman by Bose, but Saha insisted that "unless a top-ranking Congressman was made the Chairman, the decisions of the Planning Committee would be regarded as merely academic and would have no value in the eyes of the Congress"[5]. As is known, Subhas Bose thereafter nominated Jawaharlal Nehru as Chairman of the National Planning Committee, with Saha among its members.

---

* Later referred to as Subhas Bose or Bose in the text.

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Early years (1902-1913)

Unlike Jawaharlal Nehru (who received his early education in science through improvised laboratory experiments in elementary physics, chemistry from his tutor Ferdinand T. Brooks), Bose had no exposure to science in his early days. Bose (B. 23 January 1897) was sixth in a family of 8 children belonging to an upper middle class 'Kayastha' family. Having grown up in a big family, he acquired a feeling of diffidence, which made him an 'introvert'. He described his battle with "sex instinct" and development of the will to concentrate on certain particular objectives, which eventually made him a man of "one-track mind"[6]. Atmosphere in the household was that of liberal Hindu Brahmo-Samaj. He maintained his spiritual bent of the mind throughout. About his faith, in his autobiography 'An Indian Pilgrim' he writes "why do I believe in Spirit ?—because it is a pragmatic necessity. My nature demands it"[7]. In Bengal, the atmosphere during Bose's childhood (1905), after partition, was politically charged with terrorist activities of the revolutionaries. Even though Bose was not personally involved, he was deeply sympathetic. His spiritual leanings made him take a pilgrimage (1913) to the Hindu holy places of Haridwar, Benaras, Mathura, Brindaban, don the saffron robes of Sadhu in search of a "Guru". Ultimately, the teachings of Ramakrishna Paramahansa and his disciple Swami Vivekananda fired his imagination and he resolved to dedicate his life to the great cause of humanity[8].

Student days (1913-1921)

As a student, Subhas Bose had a brilliant academic career. He stood second in order of merit in his Matriculation (1913) in the Calcutta University and had first division in the Intermediate Examination (1915). He joined Presidency College, Calcutta for a B. A. course in philosophy. By that time he was deeply influenced by the spirit of the revolutionaries, incensed by the insulting behaviour of the British rulers to Indian citizens and leart that a fight-back earned respect. He had also developed into a student leader. The atmosphere in the college was also influenced by the presence of patriotic teachers like the eminent scientists Sir P. C. Ray and Sir J. C. Bose. His stay in the college was cut short by his expulsion consequent to assault by some Indian students on an English Professor Oaten, due to insulting behaviour of the latter. Bose "had in fact taken the help of the minimum number of students to give a good belabouring to the English Professor". Bose was not indentified as party to the assault but "He never let anybody down. He simply accepted the responsibility of a ring-leader though they could prove nothing definite against him"[9]. Describing his experience Bose wrote "My Principal had expelled me ; but he had made my future career. I had established a precedent for myself from which I could not easily depart in future........ I had developed self-confidence as well as initiative, which was to stand me in good stead in future .... In short, I acquired character and could face the future with equanimity"[10].

Bose was permitted to rejoin another college after a lapse of two years in 1917 for B. A. degree in philosophy. He spent the intervening period in social service—working with a team of volunteers in cholera and small-pox epidemic affected areas. In the college, he joined the University unit of the Indian Territorial Army—took musketry practice and enjoyed soldiering since it gave him "certain rights which as Indians we did not possess"[11]. He took his B. A. degree with first class honours in philosophy (1919), standing second in order of merit in the University. Unlike Jawaharlal Nehru who had full exposure to science subject in his school at Harrow, for Tripos at Cambridge and subsequently as subjects for the Indian Civil Service Examination, Bose's early years were of exposure to the surcharged terrorist revolutionary politics, anti-British social atmosphere, a spiritual quest, teachings in philosophy and some military training.

Although he joined the M. A. course, changing over to experimental psychology ; he was persuaded by his father to go to England in October 1919 for preparing for the Indian Civil Service Examination. He entered Cambridge in November 1919 taking "mental and moral sciences for Tripos", and studying Economics, Philosophy, Political Science, Geography, Sanskrit, English Composition, English History, Modern European History and English Law for appearing in the Indian Civil Service Examination. He appeared in July 1920, after a preparation of barely *eight* months and in the results appearing in September 1920, was placed *fourth* in order of merit. This was an extraordinary performance and is evidence of an outstanding brilliance of the mind. But Bose had other plans for his future and resigned from Civil Service in May 1921, wrote to Congress leader Deshbandhu C. R. Das offering his services for the service of the country.

Did the fact that Bose had no exposure or training in science subjects affect his life and political outlook ! Jawaharlal Nehru who may perhaps be considered as an ideal scientists' politician writes "It is my belief that a person who does not know something about science is incomplete in the modern world"[12]. However, lack of science education was no bar to political activity and Bose, under the guidance of Deshbandhu C. R. Das became Principal of the Congress National College, edited "Swaraj", organized and captained the National Volunteer Corps, offered civil disobedience and was jailed for six months (December 1921). After his release, Bose actively partook in flood relief work organized under the chairmanship of scientist and philanthropist Sir P. C. Ray. Bose came to science later when faced with practical problems, the solution of which needed scientific and engineering expertize.

Calcutta Municipal Corporation and Exposure to Social, Environmental and Sanitation Problems

In March 1924, Deshbandhu C. R. Das was the Mayor of Calcutta Municipal Corporation and he appointed Bose as its Chief Executive Offieer. Although his tenure in this post was brief, six to seven months (he was arrested in October 1924), he displayed a quick understanding and remarkable insight into the problems faced by the Corporation. Dealing with the drainage problems of Calcutta, the Swarajists rejected the scheme sponsored by the Government for the new drainage works as being "unscientific and useless"[13]. To Santosh Kumar Basu, who corresponded with him in jail seeking his advice and direction on the affairs of the Corporation, he wrote in detail about the drainage problem of Calcutta City, "The origin, growth and decay of rivers is a science by itself and several engineers abroad have specialized in this domain. Experiments were made with model miniature rivers to find out their possible future courses under actual conditions. A river engineer anxious to study the Vidyadhari will examine the local soil and start experimenting with his models. Until you are able to predict (or theorise about) the future of Vidyadhari area, you cannot settle the drainage scheme of Calcutta. Mr. Wilkinson or any drainage engineer may be able to cope with the second problem but only a river engineer can tackle the first problem. The Vidyadhari Committee has so far touched only the fringe of the first problem.

You may write to Dr. Bentley unofficially asking him to make enquiries about prominent river engineers in Europe and America. The assistance of the Institute of Civil Engineers in England may also be sought by the Corporation for securing information regarding river engineers"[14]. Later, Bose elucidated, to Gopabandhu Das of Orissa, the relationship between City drainage and river system and said, "........but we know so little about the origin and growth of rivers. Our engineers know precious little about rivers and public men know still less.... . The entire drainage of Calcutta depends on the future of the Vidyadhari river. While the drainage problem in Calcutta is capable of easy solution, the mysterious Vidyadhari has up till now eluded solution. Dr. Bentley, Sanitary Commissioner of Bengal is the one man I have met who has some insight into this problem"[15]. In rejection of the "unscientific" scheme of the Government proposed by Mr. J. R. Coats, Chief Engineer, Bose had the support of the Drainage Officer of the Municipality Mr. O. J. Wilkinson and Director of Public Health Dr. C. A. Bentley.

He also wrote to Santosh Kumar Basu regarding decay and wastage of food items. He wanted installation of a cold storage plant in the municipal market as "This would make it possible to preserve meat, fish and fruits which are not readily sold. A certain quantity of food rots everyday in the market and the loss is made up by raising the prices in general. It is possible to prevent this with the aid of a cold storage plant—the food supply will increase and prices will tend to fall"[15]. He suggested to Mr. Basu to get in touch with Prof. P. Parija, then professor of Botany at the Ravenshaw College, Cuttack, who was a friend of his at Cambridge and was experimenting with fruit preservation while in England. Mr. Basu could also communicate with the Ministry of Health in England or London County Council for information on cold storage. He was in favour of legislation to make primary education compulsory and was planning to "start compulsory primary education in selected areas in 1926—so that before present Corporation goes out, they will have a year's experience of compulsory primary education"[16].

In his letter to Dr. A. C. Ukil, Institute of Public Health & Hygiene, Calcutta, he wrote about the health problems confronting the Council. He had studied Caullie's 'Physical Efficiency' and McDougall's '*National Welfare and National Decay*' and a number of other books and learnt about the functioning of the National Health Commissions in U. K. which investigated whether the health of the English people had improved or deteriorated ; and if the latter the causes thereof and remedies to eliminate these. He ruefully concluded "It will probably be no exaggeration to say that no organised research in this regard has taken place in our country". About the Calcutta Municipal Corporation, he wrote "Their Health Department is largely similar to a Government Department. Nothing will be achieved until we democratise the Department". He saw the need for supply, at reduced rates of seeds, fertilizers, ploughs and cattle to the farmers, agriculture being organised on a cooperative basis to solve the agrarian problem. Bose felt that "unless we get together all the scientists and industrialists of the country and try to solve the problems of livelihood of the middle class through their united efforts, we shall probably starve to death in the not too distant future"[17].

Subhas Bose was thus well aware of the need of application of science and technology to resolve the problems of health, sanitation, food, agricultural production and other socio-economic problems. While a staunch nationalist in outlook, he was not averse to seeking foreign expertise and assistance.

Sojourn in Indian Jails (1924-1933)

Bose was arrested in October 1924 while he was still Chief Executive Officer of the Calcutta Municipal Corporation. He was in Alipore Central Jail and Behrampur Jail till January 1925 and was permitted to attend to the Corporation files. Under suspicion of his involvement with the terrorist movement, he was shifted to Mandalay Jail in Burma. The unfavourable climate and conditions of jail adversely affected his health and in 1927, Government offered to release him provided he left India for Europe. This he declined and was later unconditionally released in May 1927 after incarceration for more than two and a half years. Between then and his departure for Europe in 1933, he was in and out of jail six times. He was in Alipore Central Jail (23 January 1930 to 23 September 1930) for civil disobedience and leading an Independence procession. On release he was elected Mayore of Calcutta and Chairman of All-India Trade Union Congress. He was again detained for more than a year (2 January 1932 to 23 February 1933) in Seoni sub-jail, Jubbulpur Central Jail and Behrampur Jail—as a result of nation-wide hunt of Congressmen. He was released because he was gravely ill and sailed to Europe for treatment in February 1933.

The periods when he was out of jail were full of intense political activity and organisational work of the Congress. Like Jawaharlal Nehru, Bose was also a prolific letter writer and corresponded with his brothers (mostly Sarat Chandra Bose), nephews, mother, sister-in-law (Smt. Bivabati Bose), widow of C. R. Das (Basanti Devi) and numerous friends and colleagues. The correspondence mostly pertains to political and family matters and in the earlier period, the affairs of the Calcutta Corporation.

Bose was a voracious reader and in spite of continuous ill-health throughout his incarceration in the Mandalay jail in Burma (1924-27) and later in Seoni, Jubbulpore and Behrampur jails, he requested for and obtained a constant supply of books. The books obtained and studied by him during incarceration give some indication of the range of his interests. Netaji Collected Works Vols. I and V lists at least 64 books though there may be many more not accounted for in his correspondence. Bose was deeply interested in studies on religion and *Vedas* by various scholars. He was interested in ancient Indian history and philosophy. He was deeply interested in studies on the origin of Bengalis as a 'nationality' and considered them a mixture of aryan, dravidian and mongolian races ; also the cultural and religious origins of the worship of 'Kali' and 'Durga' and the influence of Himalayan and Tibetian cultures on the Bengali beliefs and practices. He read extensively books on Tantrik beliefs, the cult of 'Shakti' and also the lives of Sadhus and saints of Orissa, and their 'Sadhana'. He studied the physical anthropology and characteristics of various races and about the origin of various Indian languages. While books on religion, philosophy and anthropology form the main proportion of the books listed, the books on political science are few in number—even these are limited to the ones dealing with the Irish Revolution and Hungarian resurrection, the works of Herzen and the life of Lenin. Perhaps the least studied were the subjects dealing with science or its social aspects. Bose received a book entitled "Prospects of Industrial Civilisation" by Bertrand Russel, "The Research Magnificent" by H. G. Wells and "Einstein the Searcher" by a Russian.

At this stage in his career Bose does not appear to have given much attention to the role of science in India's future development. This is understandable since he had no scientific background and was deeply involved with the agitational aspects of the national struggle for independence. Surprisingly, there is little evidence of any in-depth studies of different economic or political system because by that time the Russian revolution was already making its impact on the world political scene, and Franco in Spain, Facism in Italy, and Nazism in Germany had made their appearance. Bose appears to have considered only their anti-British and nationalistic aspects, which to an extent determined his outlook in the later period.

Bose in Europe and Influence of Europe's Industrial Development (1933-36)

Bose was released on grounds of ill-health on condition that he leave for Europe for treatment. He left India in February 1933 and reached Venice early in March 1933 to be welcomed by the Italian Government. Later he proceeded to Vienna for medical check up and treatment. The fortunes of the national movement continued to occupy his mind. The suspension of the civil disobedience movement by Mahatma Gandhi evoked his strong opposition and in May 1933, along with Vithalbhai J. Patel, who was also undergoing treatment in Vienna, he issued a manifesto strongly criticizing Mahatma Gandhi's decision and called for the formation of a radical party within the Congress. In June 1933 Bose moved from Vienna to Prague and visited the Skoda Works. He also was invited to visit

Bata Works, as also glass manufacturing and some other factories. He intended to visit Moscow also but could not get the necessary visa. Between 1933 and 1936, Bose toured practically the whole of Europe to study post-war conditions and was several times in Italy and Germany. Italy occupied a place of special importance in Bose's activities and towards the end of 1933 he met Mussolini twice and had meetings with Italian officials intellectuals. He addressed student conferences and political meetings and kept in touch with the visiting Indian nationalist leaders and intellectuals. Among his constant visitors was Prof. B. B. Ray, Prof. of Physics at the University of Calcutta, who was a contemporary of Bose in the College. During this period Bose also wrote his first major publication "Indian-struggle, 1920-1934" which he completed in November, 1934[18].

At the end of November 1934, Bose flew back to India to be at the bed-side of his father who was in critical condition, arrived a day late, was arrested and interned for six weeks and returned back to Europe. He saw Mussolini at Rome in January 1935 and presented a copy of his book to him. He continued his publicity and propaganda in favour of India's freedom movement, keeping in touch with developments in India. In April 1935, he was operated upon for removal of a stone from gall-bladder and later shifted to a sanitorium at Purkersdorf near Vienna for full recovery. He was planning to shift to Karlsbad for further treatment when he was informed of Kamala Nehru's (wife of Jawaharlal Nehru) coming to Vienna for treatment. He helped with the arrangements and travelled with her from Vienna up to Prague—when she was on her way to Berlin for operation.

During his stay and travels in Europe, Bose took active interest in arranging practical factory training for Indian students. His nephew Dr. Asoka Nath Bose writes, "In 1935 and thereafter till the end of Second World War, it was exceedingly difficult if not impossible for foreigners to get into a factory for manufacture of chemicals of any kind in Germany—though it was possible to secure admission into machinery manufacturing works, textile mills and other concerns. Uncle (Bose) spared no efforts for securing facilities for practical training for me as well as for others in Germany, Austria and Czechoslovakia and ultimately it was through his efforts that I was able to obtain admission in 1936 into a chemical works in Germany manufacturing primary coal chemicals........ Uncle (Bose) was ever willing to spare time for Indian students or trainees, to meet them and discuss their problems. If anybody's scholarship was being withheld and if anybody was seeking opportunities for training or if anybody's apprenticeship allowance was being withheld, he would volunteer to write to or if necessary, see the authorities concerned for help"[19].

Bose's stay and study of Europe had convinced him of the need for training scientific personnel for India's development. From Karlsbad on 25 August 1935 he addressed a letter to the "United Press" offering suggestions as regards practical training abroad for Indian students and need for appropriate clauses for practical training in the bilateral trade agreements. While British factories raised all types of objections to practical training for Indian students, earlier, the Germans, since 1920, used to welcome them. However, since the advent of new regime, a change for the worse had come about and during his visit in

1933, he had received a number of complaints. Even students holding Doctorates in pharmaceutical chemistry from German Universities found it impossible to secure admission for practical training in German industrial chemical factories. Those with engineering degrees were being refused by all factories including Siemens and Horlske. For textile training in a spinning mill, Indians were being refused admission everywhere and they had to go to a Polish textile factory at Ludz.

Bose pointed out that German factories no longer had the freedom to admit Indian students as apprentice since every case had to be sent to a Board of the German Government for decision. He quoted the case of countries like Turkey, China, Persia, etc. who while placing substantial orders with foreign firms always made it a condition that a certain number of their nationals must be given training in these factories. These conditions were invariably accepted by foreign firms, including those in Germany. He suggested that members of the Legislative Assembly should ask the Government of India to insist on such conditions. The Indian Chambers of Commerce and Industry should also use their influence as also the Congress Party.

While England and Germany were resistant, through his contracts, other countries like Czechoslovakia (Skoda). Italy (Marelli and Pirelli) and Polish firms were agreeable to help. He pleaded that "we should turn our serious attention to this problem from today if we want to avoid surrendering helplessly to foreign experts"[20]. He suggested that bilateral trade agreements should be entered into with countries, diversifying India's trade and give preferential consideration to those giving favourable conditions for practical training of Indian apprentices in their factories. Also joint Chambers of Commerce should be established for better communication and understanding.

Bose and the Advent of "*Science & Culture*" (1935)

Since 17 June 1935 Bose had settled in Karlsbad. His nephew Dr. Asoke Nath Bose writes : "Apart from working on his next book (An Indian Pilgrim), uncle (Bose) wrote a number of interesting letters to and articles for the Indian papers during his stay in Karlsbad"[21]. Among these was also the letter to the "United Press" about factory training for Indian students, June 1935 also marked the starting of an Indian science journal "*Science & Culture*—A Monthly Journal devoted to Natural and Cultural Sciences" edited by Prof. M. N. Saha, Prof. J. C. Ghosh and Prof. B. B. Ray—Saha and Ray were well acquainted with Bose. Presumably at their invitation, Bose contributed an article entitled "Some Problems of Nation Building" to the October 1935 issue of the Journal. Welcoming the appearance of "*Science & Culture*" he said that : "........we younger folks approach the task of nation-building in a thoroughly scientific spirit and we desire to be armed with all the knowledge which modern science and culture can afford us". He pleaded that political workers were pre-occupied with their unending tasks and "it is therefore for scientists and scientific investigators to come to their rescue". He posed, what he considered a few fundamental problems to which he wanted scientific solutions. At a philosophical level he queried whether Indian civilisation was in the "evening of its life" or the impact of the West was taking it "to the threshold of a new dawn"—and "what are the conditions essential for reviving a civilisation like ours that has begun to stagnate?" On the racial problem, he queried the basis of the Nazi theory of superior races and their advocacy of endogamic marriages. If the theory was unscientific, it was a case for inter-caste and intra-caste exogamic marriages for increasing the vitality of the nation. He was also concerned about the population problem and raised the question "what is the maximum population which India should have, considering the food supply and industrial potentialities? If India has already reached that point, how should we check the further increase in population? Should artificial birth control be advocated as a public policy seeing that birth control through self-control has failed completely?"

He was deeply interested in a common script for Indian languages. He had earlier favoured "adopting of Devanagari script and abolishing the provincial scripts—but my visit to Turkey last year has made me think. I now think that the question has to be considered in a thoroughly dispassionate manner". Bose had some novel ideas about national diet and dress. He considered the "daily menu of the majority of the Indian people as unscientific and unhygienic........" and asked whether "should not steps be taken to draw up a uniform and adequate diet for the Indian people in consideration of the laws of health on one side and our circumstances on the other?" About sartorial uniformity, while he did not desire or advocate abolition of provincial dresses, he felt that "there should be a common dress which the Indian people should ordinarily wear both in India and abroad". He felt that scientists should study these problems and provide answers as an exercise in nation-building[22].

Return to India, Autobiography and election as President of the Indian National Congress

All during this period Bose continued to suffer from intestinal complaints and take treatment at various places. He stayed at Badgastein (Austria) in September 1935. At about this time, he took a leading part in the widespread protest over Hitler's speech extolling the virtues of the white races, specially of 'nordic' origin, characterising them as 'natural rulers' over other people. In January 1936, he was on the move again, visiting Prague, Berlin, Cologne, Brussels, Antwerp and Paris on his way to Dublin. He planned to return again in Badgastein (Austria) for treatment before leaving Europe for India to participate in the Congress Session. In Czechoslovakia and Germany he met leading industrialists to discuss possibilities of practical training for Indians, besides members of the Government and political parties. In Ireland, he met De Valera and other Ministers and leaders of the Irish Republican movement. Learning of the deterioration of the condition of Kamala Nehru he left for Lausanne and was there with Jawaharlal Nehru when she breathed her last. On the eve of his departure for India in March 1936, he received a communication from the British Council warning him that he would not remain at liberty if he returned to India. Nevertheless he embarked for home on 27 March 1936, was taken into custody and detained on arrival at Bombay on 8 April 1936, and later interned at Cidderpore near Kurseong. In December 1936 he was transferred to Calcutta for medical treatment and interned at the Medical College hostel and subsequently released unconditionally on 17 March 1937. His release coincided with the return of the Congress in absolute majority in seven out of eleven provinces in the elections to the provincial legislatures—with Congress winning practically all the seats in the 'general' constituencies.

After release Bose participated in the Congress activities but was mostly under treatment for his ailment and again left for Europe for medical treatment in November 1937, settling down at Badgastein. During this period he engaged in the writing of his autobiography—his second publication entitled 'The Indian Pilgrim', besides contributing articles to newspapers. In January 1938 while still abroad he was elected President of the 51st Session of the Indian National Congress. He returned to India on 24 January 1938. In between he visited England and met members of the British Government and leaders of the Labour and Liberal Parties, prominent literateurs and public men.

Bose on Industrial Development, Planning and the Role of Science and the Scientists

1938 was a very significant year from the developmental aspects of the country and the association of science and scientists with development. Congress Governments had already assumed office in seven of the eleven provinces in 1937. Nationally and internationally, the importance of Indian National Congress was being recognised and India's voice counted almost as of an independent country.

In August 1937 the Congress Working Committee under the Presidentship of Jawaharlal Nehru adopted a resolution "recommending to the Congress Ministries the appointment of a Committee of Experts to consider urgent and vital problems, the solution of which is necessary to any scheme of national reconstruction and social planning. Such surveys will require extensive data as well as a clearly defined social objectives........ Comprehensive river surveys are necessary for formulation of a policy to prevent disastrous floods, to utilise the water for purposes of irrigation, to consider the problem of soil erosion, to eradicate malaria and for development of hydro-electric and other schemes. For this purpose the whole river valley will have to be surveyed and investigated, and large-scale planning resorted to. The development and control of industries require also joint and coordinated action on the part of several provinces .. ...."

In February 1938, Bose in his Presidential Address at Haripura, paid a glowing tribute to the late Dr. Jagadish Chandra Bose, the eminent Indian scientist and nationalist. In his speech he stressed that, "Our chief national problems relating to the eradication of poverty, illiteracy and disease and to scientific production and distribution can be effectively tackled only along scientist lines"........ While earlier in 1927, he had advocated Hindi or Hindustani as common language for India, he now revised his view and said "....... I am inclined to think that the ultimate solution, and the best solution would be the adoption of a script that would bring us into line with the rest of the world. Perhaps some of our countrymen will gape with horror when they hear of the adoption of the Roman Script, but I would beg them to consider this problem from the scientific and historical points of view........ I confess that there was a time when I felt that it would be antinational to adopt a foreign script. But my visit to Turkey in 1934 was responsible for converting me". He drew attention to the population problem and said "I do not desire to go into the theoretical question as to whether India is over-populated or not. I simply want to point out that where poverty, starvation and disease are stalking the land, we cannot afford to have our population mounting up by thirty million during a single decate. If the population goes up by leaps and bounds, as it has gone in the recent past, our plans are likely to fall through". He was conscious of India's poor agricultural productivity. Besides the socio-political factors such as landlordism, rural indebtedness and lack of cheap credit, Indian agriculture lacked scientific support. He said "Agriculture will have to be put on a scientific basis with a view to increasing the yield from the land". On industrial development, he was categorical that "A comprehensive scheme of Industrial development under State ownership, and State control will be indispensable..... and the Planning Commission will have to carefully consider and decide which of the home industries could be revived despite the competition of modern factories and in which sphere large-scale production should be encouraged. However much we may dislike modern industrialism and condemn the evils which follow in its train, we cannot go back to the pre-industrial era, even if we desire to do so"[23]. It would appear that Bose was already in some communication with Prof. Meghnad Saha and the "*Science & Culture*" group since most of the above ideas in his Haripura address had been articulated in the editorials and other articles of this journal.

In May 1938, Bose convened a conference of Premiers of the seven Congress Provinces in Bombay along with some members of the Congress Working Committee and other Ministers, to discuss problems of industrial reconstruction, development of power resources and power supply and in general co-operation and co-ordination among the Congress Provinces. The conference was of the view that the Working Committee should take initiative in appointing a 'Committee of Experts' to advise the Congress Ministries. In July 1938 the Working Committee authorised the President (Bose) to convene a conference of the Ministers of Industries, call for a report on the existing industries, their needs and possibilities of new ones; as a preliminary step for exploring possibilities of an All-India Industrial Plan.

Bose called the industries Ministers' Conference in Delhi on October 2, 1938. In his address to the conference, Bose said that "... .... Congressmen have not only to strive for liberty but we have also to devote a portion of our thought and energy to problems of national reconstruction, considering that we are within sight of power and Swaraj is no longer a dream to be realized in the distant future. *National reconstruction will be possible only with the aid of science and our scientists.......*" He referred to the marvellous progress in Russia, which "has been largely due to planned industrialisation........" He quoted "the example of Russia merely because of the resemblance which the pre-war conditions there bear to those in our country and to show how far a scheme of planned industrialisation can take us on the path to all round prosperity". He visualised setting up of heavy industries, "backbone of our national economy" after "we capture power at the Centre and secure full control of our fiscal policy". Medium industries were to developed by business leaders with Governmental assistance. He saw no conflict between development of cottage industries and heavy industries.

Bose made some important observations on the principles of national planning which are reproduced below :

(a) Though from the industrial point of view, the world is one unit, we should nevertheless aim at national autonomy especially in the field of our principal needs and requirements.

(b) We should adopt a policy aiming at the growth and development of the mother industries, viz. power supply, metal production, machine and tools manufacture, manufacture of essential chemicals, transport and communication industries, etc.

(c) We should also tackle the problem of technical education and technical research. So far as technical education is concerned, as in the case of Japanese students, our students should be sent abroad for training in accordance with a clear and definite plan so that as soon as they return home they may proceed straightaway to build up new industries. So far as technical research is concerned, we shall agree that it should be freed from governmental control of every kind.

(d) There should be a permanent National Research Council.

(e) Last but not the least, as a preliminary step towards national planning, there should be an economic survey of the present industrial position with a view to securing the necessary data for the National Planning Commission.

He invited the conference to consider various issues relevant to planned industrial development such as economic surveys of the provinces, co-ordination between cottage and large-scale industries and their regional distribution, technical training of Indian students abroad, technical research and appointment of a Committee of Experts for advice on problems of industrialisation[24]. The resolution of setting up a National Planning Committee was adopted unanimously by the Industries Ministers' Conference. It was presumably to this meeting that Dr. Meghnad Saha had been invited by Bose and to which a reference has been made earlier.

The achievements of Soviet planning had influenced leftist thinkers everywhere and Jawaharlal Nehru had been equally impressed with the economic progress achieved through Soviet planning. In his letter to his daughter Indira he had written in 1933 : "The argument about the success or otherwise of the Five Year Plan is rather a pointless one. The answer to it is really the present state of the Soviet Union. And a further answer is the fact that the Plan has impressed itself on the imagination of the world. Everybody talks of 'planning' now and of Five-Year and Ten-Year and Three-Year Plans. The Soviets have put magic into the word"[25]. To Jawaharlal Nehru, planning was part of socialism. He was thus the natural choice for nomination by President Subhas Bose as Chairman of the National Planning Committee, which had also Prof. Meghnad Saha among its members. The Committee was inaugurated by Bose on 17 December 1938 at Bombay.

Bose's address inaugurating the National Planning Committee mostly dealt with problems of industrialisation. Opposition to planning and large-scale industrialisation had surfaced and he was particularly anxious to dispel any apprehension voiced by a section of Gandhite Congressmen that industrial planning would 'sabotage the movement for the revival of cottage industries'. He emphasized that State-controlled large power and machinery manufacturing industries would help to promote a large variety of light and artisan based industries. His address identified a number of key industries deserving attention of the Planning Committee besides "problems of finding the necessary capital and credit for our plans of industrialisation"[36].

Subhas Bose's Interaction with the Scientific Community

The advent of "*Science & Culture*", starting its publication in June 1935 appears to have become a means of regular communication between the community of scientists, mostly Calcutta-based, and Subhas Bose. A lot of common ground was established and Bose's ideas on planning, industrialisation, industrial research and other issues took concrete shape. In return, Meghnad Saha, B. B. Ray and others concerned with the contents of "*Science & Culture*" benefitted in having close interaction with live social, economic and political issues of the Indian situation. In his editorial in the very first issue, Meghnad Saha had written : "There still remains a large section of the population not much touched by the changes ; and even the literate and urban classes cannot reconcile themselves to the idea of the subjugation of their old system by the new conditions which are being created by modern science. *We find therefore amongst our leaders a considerable number who are incapable of* the great and inevitable part which the new age of technique will play in India's destiny and the lasting contribution that it is likely to make to the future of Indian civilization. To its readers, the "*Science & Culture*" pledged : "Lastly, the view will always be kept in mind that science is important only as long as it conducted to the development of culture and serves the cause of human progress"[37]. The Indian Science News Association (ISNA), which took over the publication of "*Science & Culture*", was inaugurated in July 1935. The eminent scientist Sir P. C. Ray was elected President and M. N. Saha and B. B. Ray as Secretaries of the Association. During the years 1935 to 1938, "*Science & Culture*" dealt comprehensively with such subjects as 'A Common Script for India' (Vol. 1, No. 3, August 1935) ; 'Industries and Scientific Research' (Vol. 2, No. 9, March 1937) ; 'Problems of Industrial Development in India' (Vol. 2, No. 11, May 1937) ; 'Fuel Research in India' (Vol. 2, No. 12, June 1937) ; 'Indian National Reconstruction and the Soviet Example' (Vol. 3, No. 4, October 1937) ; 'Need for a Power Research and Investigation Board in India' (Vol. 3, No. 8, February 1938) ; 'The Social Implications of Science' (Vol. 4, No. 2, July 1938) ; 'Need for a River Physics Laboratory' (Saha's Presidential Address to 21st Indian Science Congress, Bombay, 1934) ; 'Industrial India' (Vol. 4, No. 3, September 1938). A gradual evolution of common approach between scientists and Subhas Bose is reflected in the communication from Bose from Karlsbad in 1935 quoted earlier, Bose's Presidential Address at Haripura Session in February 1938, address at the Industries Ministers' Conference in Delhi on October 2, 1938 and the inaugural address at the National Planning Committee at Bombay on December 17, 1938.

The most significant communication of Subhas Bose's views was in his address on 'National Reconstruction', when he was invited to take the Chair at the 3rd annual general meeting of the Indian Science News Association (ISNA) held at Calcutta on 21 August 1938 preceding the Industries Ministers' Conference. Among the members associated with the Council of ISNA were such eminent scientists as Dr. S. C. Law, Sir U. N. Brahmachari, Prof. M. N. Saha, Col. (Later Sir) R. N. Chopra, Dr. N. R. Dhar, Prof. N. R. Sen, Prof. J. N. Mukherjee, Dr. D. S. Kothari, Prof. (later Sir) S. S. Bhatnagar and Prof. (later Sir) J. C. Ghosh. In his introductory remarks before the Chairman's address, Prof. M. N. Saha made a reference to the article contributed by Subhas Bose in '*Science & Culture*' in 1935 in which he had posed a number of questions to the scientists. Prof. Saha quoted extensively from historical references to respond to Bose's questions and debunk the Nazi theory of racial superiority, which he likened to "the theory of *Varnasram Dharma* in this country, which crystallised into shape about the 2nd Century A. D. (time of *Manusmriti*), when some classes were segregated from others partly on the basis of racial superiority, partly on the basis of supposed superiority of certain professions to others". Prof. Saha then put some questions to Bose asking him whether "India in future is going to revive the philosophy of village life, of the bullock cart—thereby perpetrating servitude, or is she going to be a modern industrialised nation......... If the latter, are they (the Congress) going to set up a rationalised scheme of industrialisation and establish a National Research Council and mobilise the scientific intelligensia of the country ?"[28] He referred to the confusion prevailing among some Congress leaders and ministers as to what constituted industrialisation.

Bose in his Chairman's address pointed out that "Swaraj is no longer an ideal to be attained in the distant future. On the contrary, we are within sight of power........." To tackle the problems of national reconstruction Bose invited "first and foremost the aid of scientists in this task" and pointed out that "national reconstruction will be possible only with the aid of science and the scientists. Outlining his ideas on industrialisation, he visualised the country passing "through the throes of an industrial revolution........... which like Soviet Russia has to be a forced march in this country". He believed that one of the first things "to do is to appoint a National Planning Commission for the whole country" and in this connection referred to the 1937 Resolution of the Working Committee of the Congress for appointment of a 'Committee of Experts' to advise on a uniform industrial policy and programme. This view had been confirmed by the Congress Premiers' Conference in May 1938 under his Chairmanship and recently the Working Committee had decided to convene and Industries Ministers' Conference. While maintaining that there was need to preserve and revive cottage industries, he emphasized that India would have to go in for industrialisation. He accepted that there were differences among Congressmen on this issue but "the rising generation are in favour of industrialisation ....for solving the problem of unemployment, and increasing the production of the land, improving the standard of living of the people and ushering in socialism as the basis of national reconstruction". He then for the first time listed out what he considered as the Principles of National Planning[29]. These were later repeated by Bose, without *any change*, in his address to the Conference of Industries Ministers in October 1938 and have already been described earlier[24].

In his address Bose also acknowledged that articles in "*Science & Culture*" on 'Electric Power Supply', 'Flood Control', 'River Physics', 'Need for Establishing a National Research Council' etc. had helped to divert the thoughts in the country towards the problems of industrialisation. He believed that his ideas on the problems of industrialisation and national reconstruction were held in common by scientific men and women in the country. "What is wanted", he said, "is far-reaching cooperation between science and politics'[29].

Subhas Bose's Re-election as Congress President (1939) and Scientists' Support

Towards the end of the year 1938, the war clouds were gathering in Europe. The British and French Government had shamefully compromised with Hitler and Czechoslovakia was occupied by Nazi Germany. At home differences between the right-wing and leftists had sharpened. Among the controversial issues was the opposition of conservative leaders to planning and large-scale industrialisation. Notwithstanding the declared opposition of the right-wing in the Congress to Bose's candidature for a second term as Congress President, Bose secured a victory with the support of radical wing of the Congress and the progressive groups. Among those who supported the re-election of Bose as President were eminent scientists like Sir Prafulla Chandra Ray and Prof. Meghnad Saha, besides Poet Rabindra Nath Tagore. On 7 November 1938, Sir Prafulla Chandra Ray the doyen of Indian scientists, in a statement published in *Ananda Bazar Patrika* of Calcutta said :

"Having thought on the matter deeply and after considering the current national and international political situation, I have come to the conclusion that Subhas Chandra Bose is the fittest person for the Presidentship of the Congress at the present time. I earnestly appeal to Mahatma Gandhi and the Congress High Command to seriously consider the advisability of letting Subhas Chandra continue as President for another year".

Dr. Meghnad Saha approached Poet Rabindra Nath Tagore with a request to write to Mahatma Gandhi and Jawaharlal Nehru urging Bose's re-election. The poet is known to have sent a letter to Mahatma Gandhi and written to and discussed with Jawaharlal Nehru on the subject. Saha's efforts to mobilize support for a second term for Bose for Presidentship of the Indian National Congress were presumably borne of a desire to see that constructive interaction between science and politics was ensured of a continuity[30].

Bose was re-elected but was compelled to resign on 29 April 1939. Subsequently, Bose formed a 'Forward Bloc' in the Congress, and was expelled for three years in August 1939. The Second World War was declared in September 1939 and Bose carried on vigorous propaganda against cooperation with the war efforts. The Congress ministries also resigned towards the end of October 1939. In July 1940, 'Forward Bloc' undertook a movement for the demolition of the Holwell monument in Calcutta and Bose was arrested under Defence of India Rules and detained in Presidency Jail. Mahatma Gandhi started his agitation in the form of 'Individual Satyagraha'. While in detention, Bose started an indefinite hunger-strike against his illegal and unjustified incarceration and was unconditionally released on 5 December 1940.

Bose had been preparing to leave the country and obtain external assistance for India's liberation, ever since the start of the war in September 1939. His disappearance from his residence, *incognito* travel to Kabul, efforts to migrate to the Soviet Union and subsequent migration to Germany, transfer to Japan, setting up of the Azad Hind Government and the Indian National Army and his tragic demise later are part of India's history and the national struggle for Independence. The years 1939-1945 are of little interest since Bose could not possibly have taken any interest in scientific matters or played a role in national reconstruction.

Bose and the Social Aspects of Science

A study of Bose's attitude to science would be incomplete without a consideration of his outlook on the social aspects of science. Most people look upon science as a professional activity and accept its application as a means of economic and industrial development. Their personal and social life is mostly governed by religious and traditional beliefs and practices. Others regard science as a way of life—where nothing is sacrosant unless it conforms to a rational or scientific approach. Jawaharlal Nehru belonged to the second set of people, while Bose belonged to the first.

Subhas Bose had the impress of the social environment of religious and social reform, revolutionary and political movements of the time in which he grew up. His early spiritual leanings, search for a 'Guru', acceptance of the philosophy of Ramakrishna Paramahamsa (himself a worshipper of 'Kali') and Swami Vivekananda and deep impact of the personality and politics of Deshbandhu C. R. Das (The influence of Tantras is apparent even in his daily life—Bose.) were reflected in Bose's personal beliefs. In a letter to Haricharan Bagchi from Mandalay jail Bose wrote : "The way to conquer fear is to worship Power. The images of Durga, Kali etc. are the expressions of Power. Man can attain power by invoking any of its forms in his mind, praying to Her for strength and offering all his weaknesses at Her feet........"[31].

There are several instances of his spiritual and mystical leanings related by some of his intimate co-workers and himself. S. A. Iyer who was a Minister in the Azad Hind Cabinet writes : "Many a night, after dinner, while in Singapore, he used to send his car to the Ramakrishna Mission to fetch the Swami incharge or his fellow missionary, Brahmachari Kailasam, and spend a good two hours or so in spiritual communion before retiring into his study. Sometime after midnight, to go through official papers, or late at night, he used to drive *incognito* to the Mission, there change into a priestly silk *dhoti*, shut himself up in the prayer room, rosary in hand, and spend a couple of hours in meditation. This helped him face and solve complicated problems"[32]. Brahmachari Kailasam writes : "He was a staunch believer in Divine Guidance .... He was a worshipper of the Universal Power (Sakti)[33].

Bose was however sceptical about the mystic and mysterious ways of the believers in faith cures and astrologers, even though he did not totally reject their methods. He himself writes "About this time—that is, a few days before I left for Tripuri—a number of friends began to press me to wear amulets in order to help me in recouping my health. My rationalist mind revolted against this at first, but in a moment of weakness I yielded. I accepted a couple of rings and four amulets. I accepted only those from friends whom I knew and who were not actuated by any professional motive. Amulets from people whom I did not know personally I did not wear and there were any number of them. To wear all of them would be tantamount to converting myself into an amulet-exhibition. I was so anxious to be well during the

Tripuri Congress that I argued within myself that even if these was a mere five per cent chance of my getting well by using amulets, why should I miss it ? So I compromised with my innate rationalism—but as soon as Tripuri Congress was over, I relieved myself of the two rings and four amulets. And now rationalism is safe and I trust to nature and my luck"[34].

About another interesting incidence, his nephew Dr. Asoke Nath Bose writes........"In the months of May and June 1940, during the brief periods of his stay in Calcutta, between tours, uncle (Bose) used to invite well-known astrologers and palmists from all places in India and remain closeted with them by turn for quite sometime. This was, indeed an amazing spectacle, as amongst his brothers, uncle (Bose) alone had been known to be a non-believer in astrology and palmistry. Nor had he ever been seen to consult astrologers or palmists, much less set store by their so-called predictions. The whole thing assumed a more intriguing aspect as uncle would not breathe a word about his discussions with astrologers and palmists to anyone in the family. Ultimately sometime in June 1940, shortly before his incarcerration in India, my mother (Bivabati Bose) asked uncle what it was all about. From what I gathered from her subsequently was that uncle's reply had been very pithy and all that he would say was that none of the astrologers or palmists he had consulted could give him a hint of his thinking at the time and of his future activities"[35]. This was the period when Bose would have been under great mental stress as he was planning his escape from India.

However, Bose was not a revivalist and was convinced of the need for application of Science and Technology for social and economic development. He said "we must resist the cry of 'Back to the *Vedas*', on the one side and one other side, the meaningless craze of modern Europe for fashion and change"[36], and asserted that "for a people so prone to mysticism and super-naturalism, the only hope of political salvation lies in the growth of sane rationalism and in modernisation of material aspects of life"[37]. Perhaps Subhas Bose may best be described in his own words "I have ceased to be an absolutionist (if I may use that word in my own sense) and am much more of a pragmatist"[38]. ☐

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An article on 'National Planning Committee and Science' by Jagadish N. Sinha will appear in our next issue. It was scheduled to be published in this issue.—*Ed.*

INCENTIVE FOR SETTING UP A LABORATORY EXCLUSIVELY FOR NATIVES OR INDIANS—BY MAHENDRALAL SIRCAR

ASHIM KUMAR MUKHOPADHYAY*

IN the second half of the eighteenth century, India was slowly exposed to European civilization through an increasing flow of Jesuit missionaries, European medical men, naturalists and adventures and the varied products of its arts, crafts and manufacture. Submerged by the political and military turmoils of the times, this exposure took a concrete shape towards the end of the century with the foundation of the Asiatic Society in 1784 by Sir William Jones, a distinguished scholar and linguist, deeply interested in oriental researches, Sir Jones embarked upon a programme of study, envisaging Arithmetic, Geometry, Mechanics, Optics, Astronomy, Medicine, Anatomy and Chemistry, Rehetoric, Dialectic, in fact all conceivable forms of human activity within the geographical limits of Asia, came under the purview of its study and investigation, (i).

One result of these studies, deemed to be of far reaching consequence was the rediscovery of the vitality and excellence of ancient Indian literature, science and the wide influence these had once exerted upon other cultures of the old world. Another result of no less significance was the experience of observing the work of European scientific men laying the foundation of field sciences, trigonometrical surveying, Zoology, Botany, Anthropology and so on .... (ii). The British Officers who came with the East India Company had superior technical skill and lost no time to set up organizations using modern scientific methods to explore and measure the extent of natural wealth in India. They started Royal Botanical Garden at Shibpur in 1781, Madras Observatory in 1792, Survey School in 1794 and Trigonometrical Survey at Madras in 1800. The Charter of the East India Company was renewed in 1813 with the introduction of a new clause for spending one lakh of rupees per year for the promotion of knowledge of sciences among the people of India. The initiative of Raja Rammohon Roy for introducing modern education culminated in the foundation of Hindu College in 1817. As far as instruction in sciences is concerned a promising future as opened up with the foundation of Medical College in Calcutta (1835), Madras (1843) and Bombay (1845).

During the same period Western Sciences saw the emergence of Orsted, Faraday working on electromagnetism. Maxwell formulating the mathematical basis of the electromagnetic theory of light, Hertz producing radiowaves. In the second half of the last century the telegraph and the electric light had already come to common man. This was the general scenerio of science in India and abroad when Mahendralal Sircar was trying to start the Indian Association for the Cultivation of Science—a laboratory exclusively for natives or Indians.

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Mahendralal Sircar was born in the remote village of Paikpara in the district of Howrah in Bengal on November 2, 1833, the year Raja Rammohon Roy died. Nothing much is known about his childhood except that he lost his parents at an early age and was brought up in Calcutta by his maternal uncles Iswearchandra and Maheshchandra Ghosh (iii). Thus, he had the opportunity of English education the metropolitan city offered.

Mahendralal Sircar had started his academic life in Hare School as a free student and then proceeded to Hindu College. Here, as we know from Sibnath Sastry, his thirst for knowledge further increased and he became more and more interested in, and inclined towards science. But even in this college 1854 the Science curriculum was so unsatisfactory and his ardour for science was so great that he could not resist the temptation of getting admission into the Medical College (iv). At that time the Medical College was the only college where physics, chemistry and botany were taught, by capable teachers like O'shaughnessy and Wallich.

Mahendralal came out of the Medical College with flying colours, got the prestigious M. D. degree. According to Sibnath Sastry, he was the second M. D. after Dr. Chandra Kumar Dey, with brilliant academic record to his credit, Dr. Sircar thus entered the allopathic medical profession with great promise and expectations. But when his reputation as a brilliant doctor was finally established in the metropolitan city, he was converted to homoeopathy. This conversion and the subsequent events were so dramatic that it has been called one of the most significant social events of the time.

In 1863, on the occasion of the foundation of the Bengal Branch of the British Medical Association Dr. Sircar delivered a speech utterly denoucing homoeopathy as a system of quackery and pseudo-science. Shortly he became an active member of the Association and rose to be its vice-president. This speech attracted the attention of Rajendra Dutta, the reputed homoeopath of the metropolis who tried his best to convince Dr. Sircar and to prove to him the superiority of the homoeopathic remedies, but no arguments could draw his sympathy. Though in some cases Dr. Sircar did not deny the cures effected by Rajendra Babu, but attributed them to the strick regimen enjoined.

During this time of debate and discussion Dr. Sircar received a copy of Morgan's 'Philosophy of Homoeopathy' for review in the columns of the 'Indian Field' edited by Kisorichand Mitra. He gladly consented, for he looked upon the book as a godsent and thought he would now have an opportunity of smashing homoeopathy and of proving the obsurdity and hollowness of the system. The first perusal of the book convinced him, however, that it could not be easily and logically reviewed without a previous practical acquaintance with the system. This led him to watch the progress of the cases under Rajendra Babu. After a great deal of careful study Dr. Sircar realized that his earlier views were grounded in prejudice and hearsay and become convinced about the merits of the new system. This realization led him to support the homoeopathic system propounded by Hanneman publicly in the fourth Annual Meeting of the British Medical Association.

Because of his support for Homoeopathy Dr. Sircar had to face various hard trials ; his membership of the Bengal Branch of the British Medical Association was cancelled, and the entire profession, its journals and the newspapers of the day carried out a bitter propaganda against the enfant tarrible, costing him a complete loss of practice. This would have been enough to break a man of lesser calibre. But Mahendralal withstood it all. About some of his teachers who were up in arms against him he wrote, "Whatever may have become the differences between my venerable preceptors of the Medical College and myself I shall always look back with ecastasy and gratitude on those days when I used to be charmed by their eloquence, pregnant with the words of science". He had the courage of his conviction to advocate fearlessly what he realized to be true, and that was the most remarkable trait of his character of which he gave evidence in his own words, "Professional combination is strong against me and is, likely to be stronger, every one's arm seems to be raised against me, but I cannot deprive myself of the satisfaction that mine has been and shall be raised against none".

Undeterred, Dr. Sircar gave up allopathy altogether, started practice in the system of his new faith and founded in 1868 a new periodical, *the Calcutta Journal of Medicine* for propagating his ideas and answering his critics. Within a few months his practice picked up again and soon he rose to the top of his profession. "A new spirit of awakening was created among the educated people through the lectures of Keshab Chandra, the plays of Dinabandhu, the novels of Bankim Chandra and Mahendralal Sircar's homoeopathy".

His change of faith from allopathy to homoeopathy not only enriched the homoeopathic system in the metropolitian city but also created a new outlook of his own. From his careful observation of Morgan's Philosophy of homoeopathy he rightly realized the urgent need of practical implementation of science in place of the then theoretical aptitude of science in the country. He might have realised the usefulness of homoeopathy as medical practice but his faith in science was not. In this he went one step ahead of Raja Rammohon. Raja Rammohon Roy in his famous letter addressed to Lord Amherst in 1823 made a fervent and passionate appeal for the promotion of "A more liberal and enlightened system of instruction, embracing Mathematics, Natural Philosophy, Chemistry, Anatomy and other allied subject[2]. Rammohon Roy was also dreaming of the establishments of laboratories in our higher educational institutions furnished with instruments, apparatus and necessary books. "Raja Rammohon Roy did not live to bear testimony of the fulfilment of his ambition, but within a few weeks after his demise another great son of India Mahendralal Sircar was born, who was destined to accomplish the ambition of Rammohon Roy and to give it a practical shape through the foundation of "The Indian Association for the Cultivation of Science in 1876.

We have an interesting description from Sibnath Sastri about the ridiculous science teaching in three days. "It was imperative to send native hospital assistants along with British doctors. So an ordinary school named the Medical Institution was founded with a view to producing Indian hospital assistants. There some advices were given in Hindustani about the merits of certain medicines used in western treatment. Dr. Tytler was the principal of that school. In his lecture to the students he invariably swelt at length on the virtues of soda. The students got so disgusted with the glories of soda that they nick named him 'Soda Sahib'. In fact Krishnamohan Bandopadhyay wrote an article in the newspaper on *Soda and his pupils*. Not only the description of Shibnath Sastri, a 1829 account of the syllabus in Rammohon's Anglo Hindu School reflected the similar frustrated picture of science curriculum in those days. Added to this was the widespread indifference of the British Government towards the original scientific development of the natives. This picture was clearly reflected by the writings of P. C. Ray in 1885. "A Govt. which can squander £ 10,000,000 on 'palatial' (soldiers) barracks, but which can not spare a farthing for laboratories, should forfeit the title of a civilized government".

Mahendralal Sircar rightly realized the limitation of science teaching in our country and as a basic solution of the grave problem he published an article in the Calcutta Journal of Medicine entitled "The desirability of a national institution for the cultivation of physical sciences by the natives of India" (August 1869). In this article is to be sought the origin of the "Indian Association for the Cultivation of Science" subsequently founded by him. It would therefore appear strange that a year lates, in the pages of the same journal broughtout in the defence of homoeopathy, Dr. Sircar should have advocated the foundation of a research institution for the cultivation of natural and biological sciences constituting the very foundation of the allopathic system he had denounced. Although the idea was developed and worked out during the period of a crisis of his faith in his professional carees, this had probably nothing to do with his personal crisis. Dr. Sircar's passion for science did not blaze from any impulse of puerile enthusiasm, but it proceeded from deep rooted conviction that all the defects of our nature and mind could be easily removed by the proper cultivation of the physical sciences. The influence of prejudice and superstition, debasing in all their present phases, and of time-honoured customs which, whatever their significance may be can be shaken to its foundation. As Homoeopathy is the result of scientific process of observation, generalization, experimentation to enrich his knowledge of Homoeopathy properly, he earnestly felt the need of a basic science laboratory of his own. On the others hand, the nature of research carried out in the country in those days was actually an extension of European science. The Trigonometric Survey, Agricultural and Botanical Survey, the Mining Federation, the Geographical Survey, Planters Association, Chambers of Commerce and similar organizations were very active in the field of sciences. But the fruits of their work did not percolate to the soil where they worked. Although, a few scientific institution such as Calcutta, Bombay, Madras Medical Colleges and Presidency College in Calcutta were established by the government at that time, they were exclusively manned by and meant for the Europeans. What was needed was a national institution for the cultivation of mass interest in science and for training of the Indian scientists capable of undertaking original research. He had doubtless got his ideas from the example of the Royal institution of Great Britain (1799) and the British Association for the Advancement of Science (1831).

Imbued by this great idea Dr. Sircar first proposed the establishment of such an institution in August 1869, in his learned dissertation on the desirability of a National Institution for the Cultivation of Sciences by the natives of India (August 1869, Calcutta Journal of Medicine), he emerged as a champion of western science and technology. He gave expression, in no uncertain terms, to his deep conviction that his country's underdevelopment was basically due to her backwardness in sciences, that her salvation laid in the pursuit of science by original research and that the Indians who had once attained great heights in positive science were still capable of mastering and advacing modern European sciences. He made the most important point that this could be achieved only by self help through the organization of an institution, with indigenous resources and talent "We want an Institution, he wrote, 'which will combine the character, the scope and objects of the Royal Institution of London and of the British Association for the Advancement of Science. We want an Institution which shall be for the instruction of the masses, where lactures on scientific subjects will be systematically delivered and not only illustrative experiments performed by the lecturers, but the audience should be invited and taught to perform them themselves. And we wish that the institution be entirely under native management and control.

This has now become a historic declaration as this was the first attempt to involve Indians in scientific research. It can be seen as part of the urge for self assertion, from a different stand point it can be called a turning point in the scientific awakening in the country. Dr. Sircar's insistance on the desirability of an institution under the full control and management of the Indians stemmed from his deep conviction that science was not a thing to be grafted from outside but something to be developed from within, and India had the psychological and historical make up for it. □

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Notes and news

Silver Jubilee Celebrations of IAWPC

Prevention and Control of Water and Land Pollution through Industrial Wastes is must and can be achieved by certain inplant measures and treatment of the waste to yield effluents and sludges which can be disposed of on land or water courses without any adverse effect. To assess the industrial pollution and to find out the various remedial steps, Indian Association for the Water Pollution Control (IAWPC), Nagpur Organised its Annual Conference and Exhibition on 17-19 Dec./1988 in connection with its Silver Jubilee Celebrations. B. A. Desai, Minister of State, Urban Development and Environment, Government of Maharashtra, inaugurated the 3 (Three) days Conference at NEERI auditorium. K. C. Sivarama Krishnan, Secretary (Urban Development), Govt. of India and Project Director, Ganga Project Directorate, New Delhi was the Chief Guest.

C. D. Oommachen, President, IAWPC welcomed the guests and participants. A. G. Bhole, Secretary, IAWPC, briefed the activities and achievements of the Association. He told the success story of 25 years of the Association. IAWPC is a non-profit professional organisation dedicated to promotion, advancement and dissemination of knowledge in Water Quality Management and preservation of Environment. On this occasion Arvind Bobade, Advocate General, Govt. of Maharashtra, addressed the audience on the legal aspects of Environmental protection.

The Conference was cosponsored by National Environmental Engineering Research Institute (NEERI), Nagpur, Central Pollution Control Board, New Delhi and Maharashtra State Pollution Control Board, Bombay. About 150 representatives of various governmental non-governmental and voluntary agencies took part in the Conference. Six Technical Sessions were organised on the main theme 'Environmental consequences of Industrial, Waste management and disposal activities.'

In the key-note speech, P. Khanna, Director, NEERI spoke on Water Mission and emphasised for the development of New Planning Policy for sustainable development by using existing resources carefully. He highlighted some emerging areas in Environmental Science and Engineering.

The Conference identified some important inplant measures as careful selection of products, raw materials and processes of manufacture, economy in water use, recycling of waste and recovery of pollutional constituents and more recently models and computer technology for the more effective control of pollutants discharged through waste □

S. P. Verma

Cultivation of mushrooms to fight adverse climatic conditions

The people of Rajarhat, a village of North 24-Parganas in West Bengal, have begun cultivating mushrooms to fight adverse climatic conditions. The Central Welfare Board has sponsored a mushroom training-cum-production scheme, which, in turn, is initiated by the Action Research Institute (ARI), a voluntary organisation working since 1982 in the field of "enhancement of the quality of life". The members of the institute, hailing from various walks of life—engineers, doctors, professors and scientists—carry on action-oriented researches on different dimensions of development.

K. L. Bhowmik, President of the Institute, remarked that mushroom cultivation has the potential to generate self-employment in the villages. According to him, there is a considerable demand for cultivation know-how in the districts of Bankura, Birbhum and Purulia. But the demand cannot be met due to dearth of seeds and finance. Furthermore, it is very difficult to popularise the product which has a marketable potentiality in Guwahati, Calcutta and Patna.

The cultivation and consumption of mushrooms are as old as the days of ancient Greeks who thought it to be the "Food of the Gods." Indian kings used to derive pleasure by consuming mushrooms with "soma rasa".

In India, mushroom is cultivated in Jammu and Kashmir, Himachal Pradesh and other regions possessing a cold and salubrious climate. In the eastern sector, mushroom cultivation has not been popular because of climatic and institution hazards. Its cultivation is suitable in red-soil areas and the district of Darjeeling. Being a type of fungus, mushroom is chiefly procured from the forest and constant deforestation is dwindling the supply.

All varieties of mushrooms are not edible and some are even poisonous. The detection of the edible variety has been carried down the ages by way of heredity and indigenous devices were applied by the rustic people to differentiate the non-poisonous variety from the poisonous one. But indigenous methods were not an answer to the wide-ranging demand and the requirement arose for scientific detection in laboratory. From 1970, the laboratory process in eastern India commenced. At present, Bidhan Chandra Krishi Viswa Vidyalaya and the Calcutta University Botany Department have been carrying on scientific experiments on mushroom cultivation. In India, three types of edible mushroom are cultivated : white-button mushroom (*Agaricus bisporus*), paddy-straw mushroom (*Volvariella volvacea*) and oyster mushroom (*Pleurotus* sp.). Of these, the third type can be cultivated at the lowest cost.

The material required for the cultivation include straw, nylon-net bags, polythene bags and seeds. Chopped straw is first soaked in water and later dried in a bamboo basket to get rid of the excess water. Next, the spawn (mushroom seed) is admixed with soaked straw and filled in a nylon-net bag covered with a black polythene bag. The bag is kept hanging in a shady place. After 15 days, the black polythene cover is removed and the fresh flushes of mushrooms start appearing within 3 weeks of the inoculation of the spawn.

Apart from its cheap and easy process of cultivation, mushrooms provide nutrition at a relatively inexpensive rate. Twenty grams of mushroom contain fat (1.2 gm), protein (6.31 gm), salts and vitamins. It is prescribed for diabetic patients. It has the power of combating scurvy and gingivites in infants and reducing the level of blood cholestrol. It is often administered for activating easy digestion.

Villagers in West Bengal are evincing greater interest in the low-cost cultivation of mushroom. The training programme by ARI, inaugurated in December '87, has trained 20 women in the art of mushroom cultivation. The people of Rajarhat are producing 5,000 bags of mushrooms every month by employing a large number of rural unemployed. The ARI is planning to initiate commercial production from July '88. Villages, hit by drought or flood at regular intervals, with a vast number of agricultural labourers, may find and answer to generate self-employment by adopting mushroom cultivation. □

The Statesman

Oldest fossil bee

While examining his museum's mineral collection, David Grimaldi of the Museum of Natural History in New York City, discovered an 80-million-year-old fossil bee. The specimen is twice as old as any previously known, being entombed in a walnut-size chunk of amber that was collected from Kinkora, New Jersey, USA. Grimaldi, along with Charles D. Michener of the University of Kansas in Lawrence, have studied the bee. They concluded that the bee is a hitherto unknown species under the genus *Trigona*, which has living representatives throughout tropical America. The fossil was a stingless honey-bee assigned to the subfamily Meliponinae. Since stingless honey-bees are considered highly advanced and the fossil is the oldest bee ever recorded, the researchers claim the finding may mean that bees evolved far earlier than had been thought. □

Bioscience

New possibilities for ancient Chinese medicine

Chemists at Harvard University of USA have synthesised two medicinal compounds from the leaves of ginkgo (*Gingo biloba*) trees. Used in Chinese medicine for 5,000 years, ginkgo-tree extracts or ginkgolides, are prescribed for a wide array of ailments including asthma, Alzheimer's disease and circulatory problems. Some researchers believe they could also be utilised to treat high blood pressure, eye disease, kidney disorders as well as shock and could decrease the quantity of cyclosporin—a strong immuno-suppressent causing toxic side-effects in many—required by organ-transplant patients. Ginkgolide B, one of the compounds, synthesised at Harvard, is reckoned as the most potent medicinal principle in ginkgo leaves. The synthesis of ginkgolides will assist research workers to evaluate their specific health benefits and allow drug companies to secure large amounts of the most promising compounds. □

Bioscience

International Symposium on Present and Future Perspectives in Pteridology

The Indian Fern Society is organising the above symposium during August 4-6, 1989, at the University of Rajasthan, Jaipur-302 004, India. The main themes on which the participants will deliberate will be as follows ;

(i) Morphology, Anatomy, Cytogenetics and Species Relationships ;
(ii) Taxonomy, Phylogeny, Phytochemistry and Biosystematics ;
(iii) Reproductive biology, Palynology and Experimental Studies ;
(iv) Inter-relationships of Indian Flora with African, Malesian and Chinese Floras ;
(v) Environmental Relationship, Distribution Patterns and Fern Conservation.

Persons desirous of participation may please contact for working details, the Convener, Dr. T. N. Bhardwaja, Department of Botany, University of Rajasthan, Jaipur, India.

Letters to the editor

Malabsorption in *Clarias batrachus* (L.) infected by the cestode *Lytocestus indicus* (Moghe)

Malabsorption in *Clarias batrachus* (L.) infected with *Lytocestus indicus* (Moghe) has been studied during the period 1982-1984. *L. indicus* was seen attached in the upper intestine of *C. batrachus*. It was observed that the fish infected with the cestode had slow growth rate in comparison to noninfected ones. The average growth rate of noninfected *C. batrachus* was 9.2 gm per month whereas of the cestode infected one was 4.7 gm per month. The growth rate was seen inversely proportional to the intensity of infection. The growth rate retardation was however similar in both the sexes. Living conditions and food was given same to both the groups of fishes.

On histological examinations, *L. indicus* was seen to erode the intestinal mucosa of *C. batrachus*. It had also physically compressed the villus at a number of places (Fig. 1) as a result of which mucosal epithelial cells have become flat to concave with nuclei at unusual eccentric positions. The villi were seen atrophied and fused with each other (Fig. 2) at

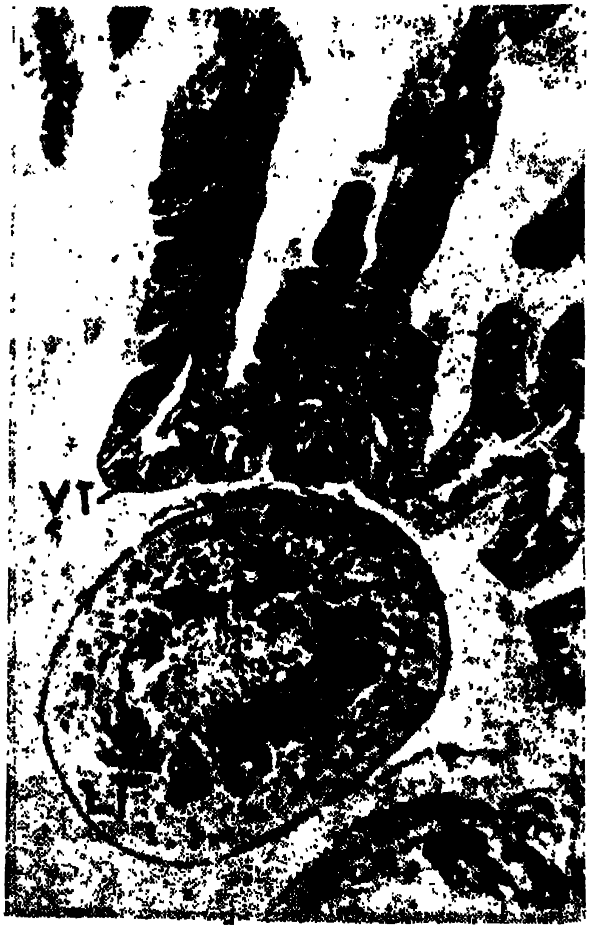

Fig. 1. T. S. of intestine of *Clarias batrachus* showing villi (VT) fused at the tip due to physical compression by *Lytocestus indicus* (LI).

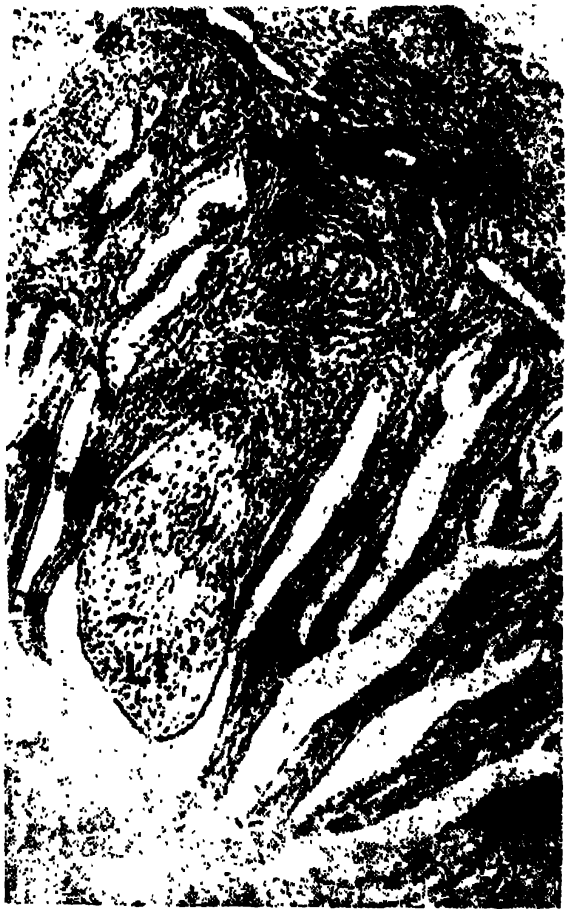

Fig. 2. T. S. of intestine of *Clarias batrachus* showing fused villi (FV) from which *Lytocestus indicus* (LI) was seen entering.

several places in cestode infected fish. The average length of a villus of noninfected intestine was 0.828 mm whereas of the cestode infected one was 0.378 mm. In an average fifty per cent of the villi of infected intestine were seen fused with each other, thus reducing the surface area.

The authors believe that the ulceration of mucosa, presence of abnormal nonabsorptive mucosal cells formed due to physical compression and reduction of surface area of villi have caused malabsorption in infected *C. batrachus*, which in turn is the major factor for growth impairment. The absorption of digested food of the host by *L. indicus* may be another factor responsible for growth impairment. The present observation confirms the view of Castro *et al.*[1] who believe that malabsorption, in guinea pigs infected with *Trichinella spiralis*, was due to flattening of the mucosa and fusion of villi. They also believe that replacement of normal columnar cells with abnormal flattened or cuboidal cells was also responsible for malabsorption. Barker[2] has also showed, by scanning electron microscopy, a severe villus atrophy and reduction of surface area in sheeps infected with *Trichostrongylus colubriformis*. Symons[3] also believes that malabsorption, in rats infected with *Nippostrongylus brasiliensis* is due appearence of nonabsorbing epithelial cells on villi and reduction of surface area due to villus atrophy. Satpute and Agarwal[4] have also reported small villi in cestode infected fish. Aubray[5] has also reported malabsorption in helminthic diseases.

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Response to *Azotobacter* and *Azospirillum* inoculation in rice and wheat crops under different fertility conditions

Among the micro-organism that are known to associate with different plants contributing to their development, the best known are the nitrogen fixing bacteria. During the last several years, field experiments have been organised in India for exploiting the beneficial effect of bacterial preparations of *Azotobacter* and *Azospirillum* for increasing crop production[1-3]. The posive trends encouraged the present authors to undertake on evaluation of the role of *Azotobacter* and *Azospirillum* inoculation of wheat and paddy under varying artificially created fertility conditions.

Field experiments were conducted in the University farms at Pura and Chakeri, Kanpur. The crops selected for these studies were wheat (Cv-HD-1553) and paddy (Cv-IR-8). The bacteria used were *Azotobacter chroococcum* and *Azospirillum brasilense*. Seeds of wheat were bacterized by uniform spraying with suspensions (10^6 cells/ml), while the seedlings of paddy were inoculated immediately prior to planting by immersion upto the root level. Three different fertility conditions in soil were created by application of varying doses of fertilizers. Fertilizers applied were urea, single super phosphate and muriate of potah ; the organic manure was farm yard manure. In each experiment one half of the total nitrogen was top-dressed one month after sowing or transplanting. The treatments were replicated four times in randomized block design. The size of the plots were 1/500 ha. Chemical characteristics of the soil of the two farms are shown in Table 1.

TABLE 1 : Initial fertility status of soil under different experiments

Particulars	Pura Farm	Chakeri Farm
Texture	Loam	Loam
pH	7.2	8.2
Available P_2O_5 (kg/ha)	6.4	12.5
Total Nitrogen per cent	0.053	0.047
Organic carbon per cent	0.33	0.42

From the experiments conducted on paddy (at Chakeri farm) inoculated with *Azotobacter* and *Azospirillum* separately and in combination (Table 2), it was observed that bacterization stimulated crop production by 6.25, 6.45 and 7.34% at $N_{90}P_{45}K_{60}$ Level and 9.37, 6.45 and 7.56% at $N_{120}P_{60}K_{60}$ level over the $N_{60}P_{30}K_{60}$ level of fertility. In case of wheat the average increase in grain yield for two years were 6.37, 10.06 and 8.19% at $N_{90}P_{45}K_{60}$ level, and 17.92, 27.48 and 27.92% at $N_{120}P_{60}K_{60}$ level over $N_{60}P_{30}K_{60}$ level. However, increases in both the crops were statistically insignificant.

The results of the experiment on wheat conducted at Pura farm (Table 3) revealed similar trends as recorded earlier for paddy. The stimulating effect of the bacterial inoculants was further accelerated by addition of F. Y. M.

TABLE 2 : Effect of seed or root inoculation with *Azotobacter* and *Azospirillum* on paddy and wheat crops grown under different fertility conditions (Yield q/ha)

Treatments	Paddy (Cv-IR-8) 1978 (Chakeri)	Wheat Cv-HD-1553		
		1978-79	1979-80	Average
1. $N_{60}P_{30}K_{60}$ + *Azotobacter*	44.48(0)	15.43	13.12	14.28(0)
2. $N_{60}P_{30}K_{60}$ + *Azospirillum*	43.09(0)	13.34	12.50	12.92(0)
3. $N_{60}P_{30}K_{60}$ + *Azotobacter* + *Azospirillum*	45.32(0)	15.43	13.37	14.40(0)
4. $N_{90}P_{45}K_{60}$ + *Azotobacter*	47.26(6.25)	16.12	14.25	15.19(6.37)
5. $N_{90}P_{45}K_{60}$ + *Azospirillum*	45.87(6.45)	15.43	13.00	14.22(10.06)
6. $N_{90}P_{45}K_{60}$ + *Azotobacter* + *Azospirillum*	48.65(7.34)	16.40	14.75	15.58(8.19)
7. $N_{120}P_{60}K_{60}$ + *Azotobacter*	48.65(9.37)	18.07	15.62	16.84(17.92)
8. $N_{120}P_{60}K_{60}$ + *Azospirillum*	45.87(6.45)	17.93	15.00	16.47(27.48)
9. $N_{120}P_{60}K_{60}$ + *Azotobacter* + *Azospirillum*	48.75(7.56)	9.60	17.25	18.42(27.92)
'F' Test	NS	NS	NS	—

Figures in parenthesis show increase percentage in yield over control.

TABLE 3 : Effect of seed inoculation with *Azotobacter* and *Azospirillum* on wheat crop grown under different fertility conditions (Pura Farm, Kanpur) (Yield q/ha)

Treatments	Inoculation conditions								
	Azotobacter			*Azospirillum*			*Azotobacter*+*Azospirillum*		
	1978-79	1979-80	Average	1978-79	1979-80	Average	1978-79	1979-80	Average
$N_{60}P_{30}K_{30}$ FYM 0 t/ha	22.13	19.96	21.05	20.75	18.51	19.63	22.88	21.42	22.15
$N_{60}P_{30}K_{30}$ FYM 20 t/ha	25.38	28.70	27.04	23.13	27.87	25.50	27.25	32.44	29.84
$N_{90}P_{45}K_{45}$ FYM 0 t/ha	27.88	22.46	25.17	23.50	21.63	22.57	28.63	24.54	26.59
$N_{90}P_{45}K_{45}$ FYM 20 t/ha	28.19	34.73	31.46	24.81	32.24	28.52	29.00	37.85	33.53
$N_{120}P_{60}K_{60}$ FYM 0 t/ha	28.25	24.96	26.60	25.00	23.50	24.25	30.37	28.49	29.43
$N_{120}P_{60}K_{60}$ FYM 20 t/ha	29.00	35.15	32.08	26.75	34.73	30.74	31.25	38.25	34.87
'F' test	NS	NS	—	NS	NS	—	NS	NS	—

Response produced by these bacterial inoculants varied from inoculum to inoculum and increases of about 25.00, 26.36 and 25.72% at $N_{90}P_{45}K_{60}$+FYM level, and 20.60, 26.76 and 18.48% at $N_{120}P_{60}K_{80}$ +FYM level were recorded due to inoculation with *Azotobacter*, *Azospirillum* alone and in association with *Azotobacter* and *Azospirillum* respectively over the respective levels of fertility without F.Y.M.

Although the increases in the crop yields were not significant, some beneficial effects of inoculation of *Azotobacter* and *Azospirillum* in rice and wheat were noticed.

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Revised: 26 June, 1988.

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Seed treatment of *Stylosanthes hamata* (L.) Taub

Stylosanthes hamata (L.) Taub., a drought-resistant fodder legume, is coming up well in areas receiving a minimum rainfall of 450-850 mm annually. These can be grown in wider range of soil and the protein contents[1] vary from 15 to 18%. The major problem in the cultivation of this legume is the dormancy imposed by the presence of hard seed coat. Though the use of solvents and acids is effective for an array of hard seeds, such treatments have practical limitation from the farmer's view-point.

Recently under the post-harvest technology scheme, Tamil Nadu Agricultural University, Coimbatore, a hand operated infra-red (IR) seed-treating drum has been developed. This unit consists of a steel frame, continuous endless flat belt with pulley and series of IR bulbs (Fig. 1). In the conveying system, feed hopper is provided at the other end. The hopper bottom is made in such a way that the seeds/grains pass through the belts in thin layer under three IR bulbs of 250 W which are placed equidistant from each other. To facilitate the movement of the seeds/grains, a belt conveyor is provided below the bulbs and the speed of the belt is controlled by the manually-operated hand-wheel. Provisions are also made on the sides of unit for inserting the thermometer to read the internal temperature.

Seeds of *Stylosanthes hamata* were sujbected to IR radiation for a period of $\frac{1}{2}$ min and 1 min. The time of treatment denotes the retention time of the seed from the entry-point of the unit till collected in the outlet. Sufficient quantity of seeds were taken for

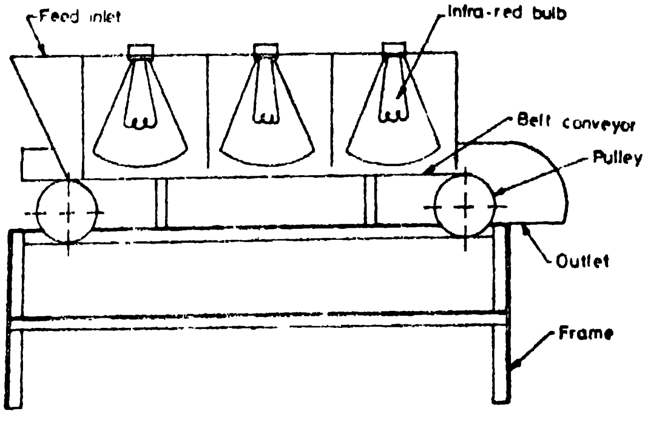

Fig. 1. Infra-red seed treating unit

TABLE 1 : Effect of IR seed treatment on the germination of *Stylosanthes hamata*

Treatment	Temp. inside the unit (°C)	Seed temperature (°C) Before treatment	Seed temperature (°C) After treatment	Per cent Germination after 21 days (Mean of 4 replications)
IR dry-seed treatment $^1/_2$ min	105	32	58	52.0
IR dry-seed treatment 1 min	105	32	72	64.0
Normal hot-water treatment	—	—	—	28.0
Control	—	—	—	4.0

Mean 37.00
SE 17.50
$\overline{X} + 1$ SE 54.50

treatment so as to have one hundred treated seeds for the germination test. Before passing the seeds, the lights were put on and the unit was continuously operated for a period of 10 min at which time the internal temperature became steady (105°C). After this, the seeds were subjected for treatment and the seeds treated were collected at the outlet in a container where a thermometer was kept to measure the bulk seed temperature. The treated seeds were subjected to germination test. Seeds were directly sown, without pre-soaking in water, under four replications with 25 seeds per replicate, in pot-culture along with the untreated check. The normal method of hot-water treatment at 55°C for 1-2 min was also included in the study.

The results of the study indicated a very good response of the seeds to the IR treatment (Table 1). A maximum germination percentage of 64 was achieved after 21 days in the IR treatment of 1 min. Germination was also found to be uniform throughout the IR-treatment. The temperature of the treated seeds varied from 58° to 72°C. Bransky and King[2], while testing the design and performance of a 'thermal aerator', found substantial decrease in hard seededness under 70-85°C temperature for 1-2 min. Differential heating between areas of seed coat cause fractures and lead to germination of seeds[3].

The present design has greater significance in fodder cultivation in the sense that the seeds can be treated and then disposed to the farmers for direct sowing, as the seeds does not require any pre-soaking in the water or pre-treatment with acid or any solvent.

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Allelopathic effects of field soils in contact with roots of three noxious weeds

In the previous communication, the allelopathic influences of three noxious weeds of West Bengal—*Amaranthus spinosus* L. (Amarantaceae), *Chrysopogon aciculatus* (Retz.) Trin. (Poaceae) and *Eupatorium odoratum* L. (Asteraceae)—on two crop plants, viz., mustard (*Brassica juncea* Czern & Coss) and wheat (*Triticum vulgare* L.)—were demonstrated[1]. In that work, extracts of the three weeds were applied to the test species in the form of aerial spray and soil dressing. Use was made of leaf- and inflorescence-extracts of weed species not only on crop plants but also on associated as well as non-associated weeds[2]. There is a need to identify interactions involving weeds (donor species) and weeds (receptor species); this aspect can be dealt with by collecting field soils in contact with roots of weeds having allelopathic potential and examining the impact of such soils at the level of seed germination and seedling growth. The purpose is to develop allelopathy as a concept in the suppression of weeds, the utility of which seems to fit the new approach to agroecosystem management[3].

To ascertain the effectiveness of inhibitors leaching out from the above three weeds at different seasons, soil samples were collected from the areas inhabited by these weeds during April (pre-monsoon), August (monsoon) and October (post-monsoon) of 1982. From each sample, the same amount (20 gm) of soil was taken separately in Petri-dishes (11 cm diam) where different weed seeds were sown after inserting a circle of filter paper and pouring 10 ml distilled water. Soils collected from the same genera are but not infested with *A. spinosus*, *C. aciculatus* and *E. odoratum* served as controls. There were four replicates per soil sample and per season. Before each experiment, receptor weed seeds were scarified (with conc. H_2SO_4 for 20 min in *Cassia sophera*, *C. tora*, *Evolvulus nummularius* as well as *Tephrosia hamiltonii* and for 2 hr in *Abutilon indicum*) to eliminate coat-imposed dormancy and washed thoroughly in water. Germination and seedling growth (root and hypocotyl length) were recorded after 5 days. Results are expressed as percent of control.

A perusal of Tables 1-3 would reveal that field soils adversely affected the seedling growth of test weeds more than their germination counts. There was growth inhibition of *Abutilon indicum* and *Evolvulus nummularius* seedlings by soil collection of pre-monsoon and monsoon period from the habital of *Amaranthus* and *Eupatorium* plants; here root growth of test seedling was more hampered than the corresponding hypocotyl growth (Tables 1 and 3). Whereas soils collected during the

TABLE 1 : Germination (G), root length (R) and hypocotyl length (H) of various weeds in field soils previously in contact with *A. spinosus* roots

Species	Pre-monsoon			Monsoon			Post-monsoon		
	G	R	H	G	R	H	G	R	H
Abutilon indicum	81.6	54.7	48.7	90.6	71.9	62.3	95.1	79.2	80.0
Cassia sophera	98.1	67.7	73.5	98.9	102.6	99.8	97.4	101.0	102.5
Cassia tora	87.6	75.5	82.0	101.0	101.9	100.2	97.0	98.0	97.6
Evolvulus nummularius	76.3	59.5	47.9	93.6	68.5	47.4	100.0	95.3	95.3
Tephrosia hamiltonii	87.0	76.5	76.0	93.8	85.5	82.9	101.3	97.8	96.5

TABLE 2 : Germination (G), root length (R) and hypocotyl length (H) of various weeds in field soils previously in contact with *C. aciculatus* root

Species	Pre-monsoon			Monsoon			Post-monsoon		
	G	R	H	G	R	H	G	R	H
Abutilon indicum	98.4	97.3	97.9	91.7	59.8	51.6	96.3	97.2	94.0
Cassia sophera	98.1	100.7	99.3	98.9	96.5	94.6	101.9	99.6	98.8
Cassia tora	102.7	106.0	101.4	97.0	97.7	93.8	101.0	96.8	96.2
Evolvulus nummularius	95.4	100.8	98.4	85.3	52.0	53.9	98.4	97.9	97.6
Tephrosia hamiltonii	98.6	99.1	99.5	95.9	87.7	82.9	104.9	104.3	102.2

TABLE 3 : Germination (C), root length (R) and hypocotyl length (H) of various weeds in field soils previously in contact with *E. odoratum* roots

Species	Pre-moonson			Monsoon			Post-monsoon		
	G	R	H	G	R	H	G	R	H
Abutilon indicum	72.0	48.3	41.7	96.8	80.5	63.9	100.9	98.8	85.2
Cassia sophera	96.0	64.5	71.3	100.9	100.6	98.0	99.7	103.5	103.7
Cassia tora	81.5	70.5	82.2	99.0	101.1	101.1	98.9	92.7	96.0
Evolvulus nummularius	72.0	59.5	44.3	89 4	86.6	56.4	100.6	100.5	98.6
Tephrosia hamiltonii	84.0	75.4	70.7	96.9	88.3	81.6	103.7	97.1	92.2

monsoon and pre-monsoon seasons from the fields of *Amaranthus* and *Eupatorium* were not so effective on *Cassia sophera*, *C. tora* and *Tephrosia hamiltonii*, the last three weeds were affected only during the pre-monsoon ; the root lengths of the two species of *Cassia* were more lowered than their corresponding hypocotyl lengths by pre-monsoon soils. The field soils of *Chrysopogon* did not inhibit the seedling growth of the three leguminous weeds during the three seasons when soil-collections were made, but the phytotoxic effect of field soils from *Chrysopogon* plants was most conspicuous on *Abutilon indicum* and *Evolvulus nummularius* during the monsoon (Table 2). However, the phytotoxicity of field soils of *Chrysopogon* was lost in the post-monsoon and pre-monsoon seasons.

It is obvious that *Abutilon indicum* and *Evolvulus nummularius* are vulnerable to field soils of *Amaranthus* and *Eupatorium* during the pre-monsoon period and to field soils of *Chrysopogon* during the monsoon. Thus, the phytotoxicity of soil samples from fields of *Amaranthus*, *Chrysopogon* and *Eupatorium* depends not only on the season when collections are made an inhibitors are released from the parent plants but also on test species on which they are applied. Since *Abutilon indicum* and *Evolvulus nummularius* are not encountered in fields of the three noxious weeds, the phytotoxic impact of field soils seem to be strong on the first two non-associated weeds. As the two species of *Cassia*, alongside *Tephrosia hamiltonii*, are normally found in the proximity of *Amaranthus*/*Eupatorium*/*Chrysopogon* plants, these leguminous weeds appear to tolerate the soils in which they are thriving in the company of their associates.

Rice[4] remarked : "The term *patterning* is used in a restricted sense by many biologists to refer to a mathematical expression of the spatial distribution of organisms within a community........ Most ecologists have attempted to explain the patterning of vegetation and the general distribution of plants largely on the basis of competition. There is little doubt that competition always plays a role in spatial distribution, but there is growing evidence that allelopathy probably plays a role also in most, if not all, spatial distribution of plants." That *Abutilon indicum* and *Eupatorium odoratum* never form a component of *Amaranthus-Chrysopogon-Eupatorium* community and the leguminous weeds (*Cassia sophera*, *C. tora* and *Tephrosia hamiltonii*) constitute a part and parcel of the same community is borne out by the present series of experiments with field soils. What inhibitors the donor weeds contribute to the soil mass in a habitat is a moot point and require further study.

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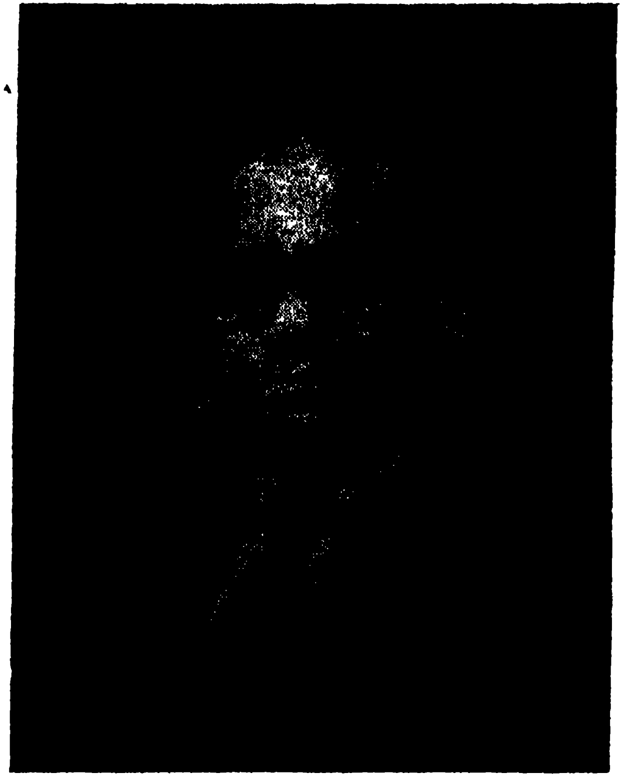
LIFE-SKETCHES OF GENERAL PRESIDENT AND SECTIONAL PRESIDENTS OF 76TH INDIAN SCIENCE CONGRESS, MADURAI, 1989

Dr. A. P. Mitra

General President



Born, 1927 ; received Master's and Doctorate Degrees in Physics from the Calcutta University under Prof. S. K. Mitra, F. R. S. ; Colombo Plan Fellow in Division of Radiophysics, CSIRO, Australia in 1951 ; Visiting Assistant Professor & Associate Professor in Engineering Research, Pennsylvania State University 1952-54; joined CSIR as Secretary, Radio Research Committee, in 1954 ; Head, Radio Propagation Unit (later called Radio Science Division) since 1958 ; Deputy Director, N. P. L. 1966 to 1973, Scientist (Director's Grade) 1974-1981, Director, NPL, April, 1982 to Feb., 1986 ; Director General, CSIR and Secretary, DSIR since Feb. 26, 1986.

Dr. Mitra's activities cover : atmospheric environment, radio communication, ionospheric physics, atmospheric chemistry and space research. His pioneering work on the use of cosmic radio noise for studies of the upper atmosphere resulted in a whole series of scientific discoveries in ionosphere, solar physics and cosmic rays. He introduced new techniques of detecting solar flares including the use of cosmic radio noise, set up at the NPL a radio flare system that in the sixties was one of the most extensive anywhere in the world, introduced new techniques of analysis of flare effects of the atmosphere and in a pioneering work showed that atmospheric chemistry changes during a flare. These works resulted in a comprehensive book that is the only one of its kind. He developed an atmospheric model from observations of satellite drag and initiated new D region rocket experiments. Dr. Mitra's work on ion and neutral chemistry in the upper atmosphere, and especially on the minor constituent nitric oxide, provided the basis for much of our present knowledge of the lower ionosphere. At the NPL he introduced a method of ionospheric prediction that has been the base of radio forecasts for HF and MF communication systems ; set up in early 1970 a school on tropospheric monitoring and propagation systems and on microwave radiometry, established an International Spacewarn System and International Urisgramme and World Day Service. In late seventies his group introduced for the first time in this part of the world an Acoustic Radar (SODAR) and carried out work on atmospheric ducting, pollution and instability. In 1979 he was awarded the prestigious Jawaharlal Nehru Fellowship. As Jawaharlal Nehru Fellow, he undertook a new work on changing environment, from both natural and human influences and brought out a monograph on "Human Influences on Atmospheric Environment".

Dr. Mitra has been recipient of many honours. He was elected Fellow of the Indian National Science Academy in 1961 and the Indian Academy of Science in 1975 ; Honorary Fellow of National Academy of Sciences ; Fellow of Third World Academy of Sciences (TWAS) in 1988 ; was elected Corresponding Member of the International Academy of Astronautics in 1963 for 'distinguished contribution to space science', and later a full Member of the Academy. He was given the Shanti Swarup Bhatnagar Memorial Award for Physical Sciences for the year 1968 ; Sir K. S. Krishnan Memorial Lectureship of the Indian National Science Academy in 1975 ; FICCI Award for Physical Sciences for the year 1982 ; C. V. Raman Award of 1980 and Shri Om Prakash Bhasin Foundation for Science & Technology Award for Electronics and Telecommunications for the year 1987. He was elected Vice-Chairman of Commission G of the International Scientific Radio Union (URSI) in 1975 and the Vice President of the URSI in 1978, and again in 1981 ; and elected President, URSI, 1984-87. He was awarded the Jawaharlal Nehru Fellowship in 1979. He has served on many national and international bodies including COSPAR. He is on the Editorial Boards of leading national and foreign professional publications in the field of solar terrestrial physics. He was elected to the Royal Society (FRS) in 1988.

Dr. Mitra has published about 160 scientific papers and has written a book on 'Ionospheric Effects of Solar Flares' which has since been translated in Russian. He has also edited several international volumes, including *Space Research*, Volume 8 and the Publication 'Advances in Space Exploration' brought out by Pergamon Press in 1981. ☐

Professor N. Rudraiah

President, Section of Mathematics

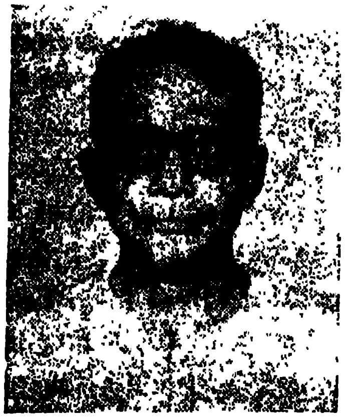
Professor Dr. N. Rudraiah, Head of the Department of Mathematics, and Principal, Central College, Bangalore University is one among the senior University Professors in the State of Karnataka. He holds several Degrees awarded by Indain and Foreign Universities. He has been teaching at Mysore and Bangalore University Departments for the past 30 years. He has taught at all levels of the University education and for the past 25 years he is active in teaching and guiding students at the Post-Graduate levels.

Professor Rudraiah has been carrying on original research on the momentum, heat and mass transfer characteristics of flows of fluids and also flow through and past porous media. Heat transfer in electrically conducting fluids permeated by magnetic fields, flows of rotating fluids with/without magnetic field, double-diffusive and triple-diffusive convection with/without rotation and/or magnetic field, Internal Gravity Waves, Internal-Alfven-Gravity Waves, Unsteady Convective diffusion, Biomechanics, Mathematical modelling of Turbulence, Chaotic motions, infinitesimal and finite amplitude study of various flows in hydrodynamics and hydromagnetics are some of the areas in which Professor Rudraiah has made notable contributions. He has guided 26 candidates for the Ph. D. degree and six students are currently working with him. During the past 25 years, he has written around 165 research papers in reputed journals. He has toured extensively through out the world and has given invited talks in several international conferences. He has also worked as a visiting scientist/Professor in Universities in Japan, Canada and West Germany.

Professor Rudraiah is an elected fellow of all the three distinguished and premier Scientific academies in the country, namely, National Academy of Sciences, Indian Academy of Sciences and Indian National Science Academy. He is also an elected fellow of the Institute of Mathematics and its Applications, Britain. He is the recipient of the FICCI National award for the year 1979 for his contributions to Science and Technology in the country. He is also the recipient of Karnataka State Rajyotsava Award for the year 1986 for his contributions to the field of education. He was confirmed with a National Lecturership by the U.G.C. in the year 1974-75. He was elected twice as the President of the Indian Society of Theoretical and Applied Mechanics in the years 1982 and 1983. He is on the Editorial Boards of some Professional Journals. He has organised one international instructional conference and several national level conferences for symposia. In recognition of the work done by Professor Rudraiah and his associates the UGC has sanctioned a DSA Programme in 1980 with thrust area 'Fluid Mechanics'.

Professor Rudraiah is a member of all the Bangalore University bodies (Academic Council, Senate and Syndicate) and has taken active interest in maintaining good academic standards in the University education. He has served as a member of numerous UGC committees including the S A C Sub-committee in Mathematics, and has made valuable contributions in planning and developing higher educational programmes at the national level. □

Professor S. K. Chatterjee
President, Section of Statistics



Professor Shoutir Kishore Chatterjee was born at Ranchi in Bihar on November 6, 1934. He had his education from Burdwan Raj Collegiate School and College and later from Presidency College and Calcutta University.

After passing his M.Sc. Examination in 1956 Professor Chatterjee started working as a Research Scholar in Calcutta University under the supervision of Professors P. K. Bose and H. K. Nandi. He submitted his doctoral thesis in 1960 and on its basis was admitted to the Ph.D. degree of Calcutta University in 1962.

Professor Chatterjee joined Calcutta University in 1960 as a teacher of Statistics and since then has been working there in different positions except for a two-year stint (1966-68) as Reader in Lucknow University and a one-year tenure (1972) on a visiting appointment to the University of North Carolina at Chapel Hill, USA. He has been Professor of Statistics, Calcutta University since 1979 and has served as Departmental Head during 1981-83.

Professor Chatterjee's research interests have broadly encompassed Statistical Inference and Design and Analysis of Experiments. His doctoral work consisted in extending Stein's two-step procedure to the unsolved case of multinormal mean vector and regression with stochastic predictors. Later, in collaboration with his then colleague Professor P. K. Sen, he successfully attacked the problem of extending existing univariate nonparametric tests to multivariate set-ups. The approach to nonparametric multivariate analysis initiated by them led to a large volume of work by many workers here as well as abroad. Professor Chatterjee later made contributions to the topic of testing against restricted alternatives. Here he and his students showed a new way of utilizing the Union-Intersection Principle and were able to demonstrate in important particular cases, the improvement in performance achieved by the restricted techniques so derived. These works were followed up and extended by a number of workers here and abroad. Professor Chatterjee has also worked and guided work in sequential nonparametrics, combination of scores, variable selection and other related problems of inference. In the area of Design and Analysis of Experiments he has worked and directed work an asymmetric factorial designs and their orthogonality, optimality of response surface designs and estimation of variance components under complex set ups. Besides he has always evinced a global interest in various other domains of statistical theory and applications including sample surveys, crop forecasting, process control etc. The above contributions have appeared in a large number of papers in various international journals and publications.

Professor Chatterjee in his long academic career has given talks and chaired sessions in many national and international conferences. In particular he was an invitee to the First International Symposium on Nonparametric Inference held at Bloomington, Indiana in 1969. He has acted as a resource person in advanced level symposia and institutes. He acted as a member of the UGC panel in Statistics during 1981-85. He was appointed a National Lecturer for 1985-86 by the UGC. Besides he has been associated with a large number of institutes and universities as member of the various academic bodies and with a number of Indian and foreign journals as a referee and reviewer. Since 1978 he has been editing the journal 'Calcutta Statistical Association Bulletin'. □

Professor D. K. Rai

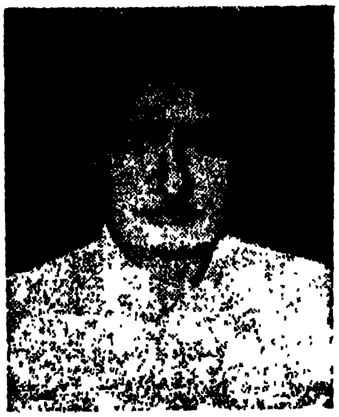
President, Section of Physics

Dr. D. K. Rai was born on Nov. 20, 1943 in village Reotipur, Dist. Ghazipur in east U. P. Dr. Rai received his school, College and university education in Varanasi. He passed the M.Sc. Physics-Spectroscopy examination of Banaras Hindu University in 1961 securing the highest percentage of marks amongst all the successful candidates. He received the Chancellor's Gold Medal for that year in addition to other prizes and was appointed lecturer in the university. In addition to his teaching duties, hs also joined as a Ph.D. research student under the supervision of Professor Nand Lal Singh. He carried out an extensive investigation on the inter-atomic potential as derived from spectroscopic studies both for diatomic and for highly symmetric polyatomic molecules. His work has been quoted in standard texts and reference books. He was awarded the Ph.D. degree in 1966.

D. K. Rai was awarded the Swedish International Development Authority fellowship for post doctoral work (1965-66) in the famous Institute of Quantum Chemistry at the Uppsala University. He studied semi-empirical and ab-initio quantum chemistry as applied to both simple diatomic and complex bio-molecules. After his return to India, he built up one of the first centres for quantum chemical studies in the country. A new simplified method for determining geometry changes on electronic excitation of substituted benzenes was developed and used with success. Rotational analysis of diatomic spectra was also vigorously pursued and many new molecular states were discovered. During 1976-77, Dr. Rai was senior von Humboldt fellow at the University of Erlangen-Nurenberg in West Germany. He studied the modifications needed for carrying out relativistic calculations on atomic systems with more than 2 electrons. His study of density of states in poly containing hydrogen impurity has acquired significance in recent times due to the development of high temperature superconductors. His current interests include quantum biochemistry and theory of atomic collisions in addition to laser optogalvanic spectroscopy and other applications of laser.

He as the convener of the yearly meetings of the Laser and Spectroscopy Society of India during the years 1979-1984. He was Recorder for the Physics Section of Indian Science Congrees for the years 1987, 1988. He is currently National Executive Member of the Indian Society of Atomic and Molecular Physics and is on the editorial board of the Indian Journal of Physics, and the Indian Journal of Pure and Applied Physics. He is also the chief editor of PRAJNA.

Professor P. C. Gupta
President, Section of Chemistry



Professor P. C. Gupta, born on January 4, 1927, had his early education at his home town, Orai in Uttar Pradesh. After passing the Intermediate Examination in Ist Class in 1946 from B. N. S. D. College, Kanpur he joined the University of Allahabad. In 1951 he won the award of "Kanta Prasad Research Scholarship" of the University to conduct research on the Chemistry of natural products with particular reference to indigenous plants, his work winning for him the D. Phil. degree of the University in 1954.

Dr. Gupta joined the teaching fraternity in Chemistry in the University of Allahabad the same year, later becoming Reader and finally professor in 1984. He also served the University in various administrative capacities such as proctor, warden, President, Atheletic Association, Dean, Students' welfare etc.

His early research interest had been in the polyphenolics from plants and he later diversified it to include the carbohydrate chemistry, particularly carbohydrate biopolymers from plants. He has done extensive research work on the structural elucidation of plant seed polysaccharides. Two of his products from plant gums and mucilages are being used as food thickners in Germany (F. R. G.) and other European countries. These chemical investigations by Prof. Gupta have centred round the different species of Cassia, Ipomoea, and Crotalaria genera.

Prof. Gupta developed sustained interest in synthetic organic chemistry also. Since 1965, he has been pursuing studies on novel reactions of γ-ketoacids-synthesis of unsymmetrical phthalein analogues containing chiral C atom, which may be designated as phthal-as-eins and succin-as-eins. He extended these studies to ring-chain tautomerism and proximity effect observed in these compounds. While investigating these compounds, he has discovered that benzoylation of acyclic γ-ketoacids results in an unexpected product which exhibits biphenyl type of atropisomerism.

In 1971, Prof. Gupta was awarded the Commonwealth Scholarship which gave him the opportunity to work in the porphyrin research group of Prof. Clezy in the University of New South Wales, Australia. In 1972-73, he was in Sydney under the Colombo Plan and UNESCO Exchange Programme. Prof. Gupta has since diverted his interest to include Chemistry of porphyrins of biosynthetic significance and biological importance. He has been successful in developing new routes of elegant and unambiguous syntheses of a number of pyrroles and dipyrryl compounds.

About 35 research students have obtained their doctorate degrees under the supervision and guidance of Prof. Gupta. He has published more than eighty original research papers in reputed international journals. Prof. Gupta is a Fellow of National Academy of Sciences, India and a member of the Society for Medicinal Plant Research, Germany (F. R. G.). He was elected Recorder of the Section of Chemistry, I. S. C. A. in 1983 and 1984. He is also the General Secretary, Vijnana Parishad (Hindi Science Academy), Allahabad.

Dr. M. N. Mehrotra

President, Section of Geology & Geography

Dr. M. N. Mehrotra, Professor of Geology at the Banaras Hindu University was born on April 12, 1929 at Kashipur Distt. Nainital, U. P. He had his early education at Udai Raj Hindu High School, Kashipur and higher education at the Banaras Hindu University, obtaining M.Sc. (Geology) in 1951. One year later he was appointed as a lecturer in the same University. In 1961, he was selected for the fellowship of the Alexander Von Humboldt Foundation, West Germany. He specialised in Petroleum Geology and obtained the degree of Dr. rer. nat. from the Technical University, Aachen in 1964. He was invited again by the same Foundation as a Visiting Fellow in 1975. Dr. Mehrotra became Reader and Professor in 1964 and 1978 respectively and was Head of the Department during 1982-84.

Prof. Mehrotra's research contributions are in the field of Sedimentology, its applied aspects, and Environmental Geoscience. His studies are mainly devoted to Vindhyan Sedimentation in the Son Valley with emphasis on the utility of carbonates, to Krol-Tal basin (Mussoorie) with special reference to phosphorites and carbonates and to Recent sediments with special reference to the effect of effluents on Ganga sediments. This last one has established the significance of the study of sediments in environmental conservation and management programmes. He was the Chief Coordinator of the Ganga Water Pollution Project at Banaras Hindu University from 1980-85.

Professor Mehrotra has so far guided fifty M.Sc. dissertations and eight of his students have been awarded Ph.D. degree by B. H. U. He has to his credit more than seventy research papers in reputed Indian and foreign journals and about a hundred technical articles. His book 'Prithvi ki Ayu' (Age of the Earth) published by the Hindi Samiti, Government of Uttar Pradesh, is in its second edition. He has also translated the standard Text Book of Mineralogy by Dana and Salisbury in Hindi. Besides he has made significant contribution to the Geological Terminology and has been an expert member on its Advisory Committee. Also, the first ever Ph.D. thesis in Geology in Hindi was submitted under his supervision in 1974.

Prof. Mehrotra is widely travelled and has participated in national and international congresses/symposia. He is a fellow of several professional societies in India and abroad ; was National Correspondent of the International Association of Sedimentologists (1975-82), a Member of the IUGS Committee on Sedimentology (1982-87), and Convener of the 3rd Convention of Indian Assoc. of Sedimentologists and the symposium on 'Energy Resources Associated with Sediments (1980). He was the Recorder of Geology and Geography Section, ISCA (1980-82), and the President of the Indian Association of Sedimentologists (1985-86). Besides, Prof. Mehrotra is on the editorial board of several scientific journals including the CSIR Journal 'Vigyan Pragati'. The President of India nominated him Director (Non-Official) of the Mineral Exploration Corporation of India Limited, for the period 1986-89.

Professor R. P. Purkayastha

President, Section of Botany

Professor R. P. Purkayastha was born in Sylhet now in Bangladesh on 31st August, 1935. He had his early education at the Raja G. C. High School, Sylhet. Having graduated with honours in Botany from the City College, Calcutta he joined the University College of Science and passed the M.Sc. examination of the Calcutta University in 1958 securing First Class. After a short stay as a Lecturer at the Rammohan College and City College, Calcutta he proceeded to the United Kingdom for higher studies in 1962. He obtained his Ph.D. degree and D.I.C. from the Imperial College of Science and Technology, University of London in 1965. While at the Imperial College he was awarded the Old Students' Royal College of Science Research Scholarship in Botany. On his return from England he continued his Post-Doctoral Research in the Department of Botany, University of Calcutta for sometime and then joined the Visva-Bharati University as a Lecturer in Botany in 1968. Next year he returned to the University of Calcutta becoming a Lecturer in Botany where he is at present serving as a Professor.

Being encouraged by Professor R. K. S. Wood, F. R. S. of the Imperial College, London, Professor Purkayastha initiated work on phytoalexins in the United Kingdom in 1962 under the guidance of Professor B. J. Deverall at the Imperial College and conclusively demonstrated the involvement of phytoalexin in the differential resistance of broad bean to fungal pathogens. Later, he pursued his research on the role of phytoalexins in disease resistance of rice, jute, soybean and groundnut in India. In addition to his work on phytoalexins, his researches on phytoimmunity, induced resistance, biological control of crop diseases and pesticidal effects on biochemical defence of crop plants are also noteworthy. He and his associates first pointed out that disease resistance could be induced in susceptible plants by alteration/regulation of specific host antigens.

Prof. Purkayastha has also made significant contributions to the field of mushroom science. Cultivation technology of a new species of edible mushroom has been devised which could be exploited for cultivation on a commercial scale in the country. The possibility of bioconversion of raw jute and jute wastes for the production of protein food through mushroom cultivation has been demonstrated by him and his associates. He is the co-author of the first book on Indian Edible Mushrooms and also of two other books. He has built up an active school of research on physiological plant pathology, phyto-immunology and edible mushrooms in the Department of Botany, University of Calcutta and has more than 140 research publications including 12 reviews in several reputed National and International Journals. A large number of students have obtained their Ph.D. degrees under his guidance.

Professor Purkayastha was invited and contributed papers to the Second International Congress of Plant Pathology held at the University of Minnesota, U.S.A. ; 3rd International Congress of Plant Pathology held in Munich, West Germany in 1978 ; XI International Scientific Congress on the cultivation of Edible Fungi held in Sydney, Australia in 1981. He also visited several Universities in U. K. in 1978 as a British Council Visitor and in 1982 again under the INSA-Royal Society Exchange of Scientists Programme.

Professor Purkayastha was elected a member of the New York Academy of Science in 1981. He is also a Fellow of the India Phyto-pathological Society, New Delhi, and is associated with several National and International Societies and journals. He was a member of the Scientific Panel of Plant Pathology, ICAR, New Delhi from 1982-85. Prof. Purkayastha was also elected President of the Indian Mycological Society for the Session 1987-88 □

Professor V. C. Shah

President, Section of Zoology, Entomology & Fisheries

Vinodkant Chunilal Shah, Born on 27th Nov., 1929, Married ; Father of Three Daughters, M.Sc. First Class First. M. S. Univ., Baroda ; M.S. from Univ. of Minnesota, U.S.A. ; Ph.D. Columbia University, New York, U.S.A. D.Sc. Arizona Univ. (U.S.A.) ; Research Associate Brookhaven National Laboratory, Long Island U.S.A. ; Instructor, Tufts Univ., Boston ; Lecturer Sydney Univ., Australia ; Reader, Delhi University, Delhi ; Professor of Zoology and Director, University School of Sciences, Gujarat Univ., Ahmedabad. Visiting Professor at Sydney University, Australia ; Kyoto Univ., Japan ; Julich Institute of Nuclear Medicine, West Germany ; California, Wesleyan and Florida Universities, U.S.A. Won many awards including Hari Om Mota Prizes for best contribution in Natural Sciences ; Awarded Fulbright Fellowship. American Govt. ; K. G. Naik Gold Medal for best contritution in Science in Gujarat State. Fellow of National Academy of Sciences (Allahabad) ; Fellow of Indian National Science Academy. Fellow and President of Gujarat Academy of Sciences ; President, All India Cell Biology Society ; Executive member of many National bodies. Ex-member of Biology Penal, University Grant Commission, Member of Biology Penal, Council of Scientific & Industrial Research (CSIR), Govt. of India ; Member of the Court, Academy Council and Executive Council of Gujarat University. Dean, Faculty of Science, Gujarat University. Published over 130 papers in the field of Cell Biology and Cytogenetics. Guided nearly 20 students for Ph.D. Degrees ; Written three books on Radiation Biology, Genetics and Cell Biology. Executive member of Dept. of Science and Technology, Gujarat Government. Adviser, Gujarat State Pathya Pustak Mandal for production of Higher Secondary Board Biology Books ; Adviser on Science Programmes Doordarshan (T.V.), Govt. of India ; Elected Vice President, Asia Pacific Organisation of Cell Biology (APOCB) and Vice President, International Federation of Cell Biology. □

Professor A. R. Banerjee

President, Section of Anthropology & Archaeology

Professor Amulya Ratan Banerjee, Ph.D., F. A. F. Sc. was born on 29th November 1930 at Dakhingram in Birbhum District of West Bengal. After his early education in village and subdivisional schools he graduated with distinction in Biological Sciences (1951) and took his M.Sc. degree in Anthropology (1954) from University of Calcutta. He started his research career in the Department of Anthropology, University of Calcutta as Research Scholar, Government of West Bengal (1955-58) under supervision of Dr. S. S. Sarkar and was subsequently awarded Research Fellowship (1958-60) of the University of Calcutta. He was awarded Ph.D. degree in 1960 and continued researches as Post-Doctoral Fellow of University Grants Commission (1960), Research Fellow of National Institute of Sciences of India (1960-63) and part-time Lecturer of Department of Anthropology, University of Calcutta (1963). During tenure of above mentioned assignments he undertook extensive field-works among different tribal populations of Orissa, Madhya Pradesh and Kerala with a view to working on different problems of Physical Anthropology and Human Genetics.

In 1963 he was awarded the Alexander von Humboldt-stiffing Post-Doctoral Fellowship to work with Professor Von Verschuer in the Institute of Human Genetics, University of Muenster, West Germany. He worked there extensively in the field of Twin Genetics, Human Cytogenetics (along with Professor H. Schade) and Forensic Anthropology. After his return in India (1964), again he took up teaching assignment in the Department of Anthropology, University of Calcutta. That assignment is still being continued by him. Along with teaching and research work in the Department of Anthropology he developed Genetics Research Unit in the Ramkrishna Mission Seva Pratisthan (Vivekananda Institute of Medical Sciences), Calcutta, to conduct research in Medical Genetics and Reproductive Biology.

Professor Banerjee has been active in his field for more than three decades. His contributions earned International recognitions in the field of Physical Anthropology, Human Genetics, Human Biology and Forensic Anthropology. His pioneer contribution on morphological and histological characteristics of human head hair of the Indian aborigines, specially the Kadar of Kerala, the Onge and the Andamanese of Andaman Islands, not only settled but also removed the erroneous concept of Negrito racial origin of the Indian aborigines.

He along with his associates estimated heritability of the different components of histological and histometrical characteristics of human head hair and eventually established that hair could be well utilised as a criteria for personal identification, twin study and also could be utilised in the field of growth study.

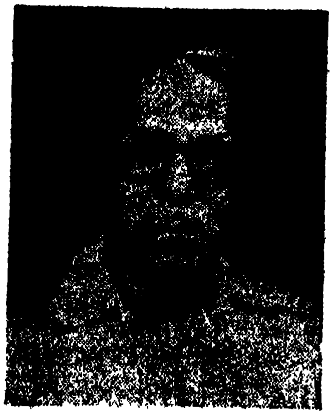
His contribution along with Professor Curt Stern and Dr. S. S. Sarkar on hypertrichosis of the ear rim was significant for understanding of Y-linked inheritance in man. He built up a school of young scholars and along with them contributed significantly in the following areas :

(i) Natural Selection in blood group polymorphism (specially ABO) caused by incompatibility selection against heterozygotes resulting in to couple infertility, birth wastage and haemolytic disease of the new born (HDN), (ii) Impact of socio-economic factors on (a) Reproductive biology, (b) Growth and development of children, (iii) Application of Anthropogenetic methods in Forensic Sciences, specially in Medico-legal cases, relating to paternity diagnosis, (iv) Genetic counseling and prognosis of diseases by utilizing methods of Anthropol-genetics, including cytogenetics and pedigree analysis. He along with his associates published more than 80 original papers, one monograph and two books. Six scholars obtained Ph.D. and D.Sc. degrees working under his supervision.

Professor Banerjee has been associated with the Science Congress for more than two decades. He served the Anthropology and Archaeology Section in the capacities of Sectional Committee Member (1966) and Recorder (1968-69). Besides the above positions, he had been Anthropological Secretary of Asiatic Society (1982-85), Member of the Academic Council, Calcutta University (1973-1978). He is the President of the Academy of Forensic Sciences, Calcutta Branch and is Associated with a number of learned organisations, and also connected with several scientific journals in the capacity of Editor and member of Editorial Board ☐

Dr. B. Dattachaudhuri

President, Section of Medical & Veterinary Sciences



Born in 1931, Dr. Basudeb Dattachaudhuri passed Matriculation Examination from Calcutta University in 1947. All along with a brilliant academic record he became a medical graduate from the Medical College, Calcutta in 1954. He also acquired D.C.P. and M.D. degree from Calcutta University. As a researcher in several research projects, Dr. Dattachaudhuri worked in muscle physiology, cardiovascular physiology, neurophysiology, endocrinology and cholesterol and fat metabolism. After being awarded Ph.D. degree from Calcutta University for his thesis on cardiorespiratory physiology in 1965, he joined the teaching career in the Department of Physiology, University College of Medicine; Calcutta University in 1966.

Dr. Dattachaudhri has to his credit about 50 research papers published in different journals as a mark of his commendable research activities in the field of several aspects of physiology, pathophysiology and investigative medicine. He has guided several Ph.D. and M.D. students in their thesis work who have come out successfully. His recent interest is in the investigation of sociomedical problems in Indian adolescents, which is a burning question of the day, and he has an ample contribution and constructive suggestions on this subject of national importance.

Being a life member of Indian Science Congress Association, he was elected twice a member of the Sectional Committee and Recorder in the Section of Medical & Veterinary Sciences. He is also an active member of several professional societies and various medico-social organisations like I.M.A. and A.P.P.I. Red Cross Society, St. Johns Ambulance etc.

Dr. Dattachaudhuri is author of several popular scientific articles in Bengali and contributor to an anthology of articles on diseases and their cure. He is also author of a Bengali book on adolescence published by State Book Board which has been praised in all quarters of the society as an authentic and useful monograph. He has also edited an English translation of a Russian Book on neurophysiology. □

Professor Anupam Varma
President, Section of Agricultural Sciences¶

Professor Anupam Varma, born in Delhi on July 23, 1940, received early and university education in Allahabad. In 1960 he was awarded Chancellor's Medal for the best post-graduate student of all the Faculties of Allahabad University, and secured first position in the University in M.Sc. (Botany) in 1961. He started his research career with investigations on post-harvest diseases of fruits and vegetables under the supervision of Professor R. N. Tandon at Allahabad University, and in a short time found several new genera and species of fungi causing post-harvest diseases of fruits and vegetables. In 1964, he was awarded a Commonwealth Fellowship to work at Rothamsted Experimental Station, U. K. for Ph.D. in Plant Virology under the guidance of Sir Frederick Bawden and Dr. Adrian Gibbs. He received Ph.D. degree of London University in 1967.

Since his return to the country in 1967 he is working at the Indian Agricultural Research Institute, New Delhi, where presently he is the Head, Division of Mycology & Plant Pathology and Advanced Centre for Plant Virology. He has also worked (1979-81) for the Food and Agriculture Organisation of the United Nations as an Applied Plant Virologist to help in the establishment of a plant virus diagnostic centre at the National Horticultural Research Institute, Ibadan, Nigeria. He was a Visiting Fellow with Virus Ecology Group, Research School of Biological Sciences, Australian National University, Canberra in 1977 to work on interrelationships of tobamoviruses and ultrastructure of a Reovirus. In 1986 he worked at the Scottish Crop Research Institute, Dundee, U. K. on cloning, c-DNA, monoclonal antibodies and electronmicroscopy of Geminiviruses.

Professor Varma has made important contributions to both fundamental and applied aspects of plant virology. He has determined the structure of a large number of flexible anisometric viruses, and described distinct arrangements of protein subunits in helical symmetry with a pitch of c-33Å in different groups of such viruses. Elucidated complicated structure by *in-situ* electronmicroscopy of a Rhabdovirus which was the first of its kind to be described from India. He has demonstrated usefulness of *in-situ* electronmicroscopy in detecting unknown viruses like the lily Reovirus. He has characterised many viruses, and developed sensitive detection methods for use in testing seed and planting materials. He initiated research on mycoplasma diseases of plants in India and opened a new dimension to very important disease like sandal-spike and little-leaf of brinjal. He also proved the etiology of both vegetative and floral malformation of mango. He has made important contributions to the study of epidemiology of virus and MLO diseases and has developed effective control measures. He demonstrated the significance of the size of meristematic tissue required for eliminating viruses by meristem culture from plants and obtained virus-free clones of several cultivars of potato and horseradish infected with viruses belonging to different groups. He has published more than one hundred research papers and written and edited several books. Prof. Varma has established a strong school of plant virology in the country.

He is a member of several professional societies of India and other countries. He is Secretary of the Indian Phytopathological Society, Editor of the International Journal of Tropical Plant Pathology and recipient of World Food Day Award of the FAO and IAAS in 1985. Prof. Varma is a Fellow of the Indian National Science Academy, National Academy of Sciences, India, and Indian Phytopathological Society. □

Dr. H. P. Chattopadhyay

President, Section of Physiology

Dr. Haripada Chattopadhyay was born in Shikarpur, Barisal district of undivided Bengal in 1928 and went to school (G. G. Institution) of his native village. He passed the Matriculation Examination from that school in 1942. Came to Calcutta and studied in N. S. Dutt College, Howrah for his I.Sc. examination in 1944. Was admitted to Presidency College, Calcutta to study for the B.Sc. (Hons) degree of the Calcutta University with physiology as his major subject and Physics & Chemistry as minor subjects (1944-46). He also studied for the M.Sc. degree of the Calcutta University at the Presidency College, Calcutta (1946-1948).

After obtaining the M.Sc. degree of the Calcutta University with a First Class in 1948, started to work as a Research Assistant of Prof. G. N. Bera in the Dept. of Physiology, Presidency College, Calcutta on the effect of nicotinic acid on carbohydrate metabolism. Later became a research assistant of Prof. D. P. Sadhu (at the Presidency College and also at the Bengal Veterinary College, Calcutta) and worked on the mechanism of action of vitamin A in the body. Then he joined Prof. S. Banerjee's team of research workers in 1953 and started working on the nutritional values of germinated pulses for which he was awarded the Ph.D. Degree of the Calcutta University in 1954. He was been a research student of Prof. S. Banerjee during 1950-51 and 1953-58. He worked with him on vitamins of germinated pulses; metabolism of nicotinic acid and metabolic action of alloxan.

Dr. Chattopadhyay went to USA for higher studies in 1960. He was a post-doctoral fellow in the Biochemistry Dept. of North-western University Medical School, Chicago, during 1960-63. He worked there with Prof. Smith Freeman on the mechanism of action of parathyroid hormone. Coming back to India, he started working with his former student and colleague, Dr. S. Lahiri (now in the USA) on the Physiology of high altitude on a project financed by the Indian Council of Medical Research. After the departure of Dr. S. Lahiri to USA, in 1965, he continued with one of his graduate students, to work on the project on the "Physiology of adaptation to high altitude" for another five years. Later he started work on "Physical work capacities and nutritional status of urban and rural athletic students" for which one of his graduate students was awarded the Ph.D. degree of the Calcutta University in 1980. He also worked on the physiological adaptation of the salt workers in the coastal districts of West Bengal. One of his students obtained the M. Phil degree of the Calcutta University for this work. At present, he is guiding a few students for their Ph.D. degree in the fields of (i) Chronobiology of Physiological Adaptation to shift work in Industry, (ii) Chronobiology of the ultradian nasal cycle of humans under various conditions of stress and (iii) On the nutritional status and adaptation to hypoxia in the native hill people of medium altitude of the himalayan regions of U. P. He has published about thirty original scientific papers in Indian and foreign journals. He has been teaching in the undergraduate Honours classes and post graduate classes of Physiology for the last thirtyfive years (1953-1988).

He is a life member of the Indian Science Congress Association ; the Physiological Society of India ; the Science Club, Calcutta ; and an ordinary member of the Association of Physiologists and Pharmacologists of India ; and the Indian Renaissance Institute, New Delhi. He is the President of the Physiological Institute, Presidency College, Calcutta, and also the Founder-President of the Indian Society of Ergonomics. Dr. Chattopadhyay attended many international conferences in India & abroad. At present, he is an Assistant Professor of Physiology at the Presidency College, Calcutta. ☐

Dr. V. P. Sharma

President, Section of Psychology & Educational Sciences

Dr. Vishnu Prasad Sharma is Professor of Psychology and Head of the Department, Ravisankar University, Raipur since December 1983. He was born on 28th December 1928 in Raipur (M. P.), in a very poor Brahmin family, and has acquired rich experiences of poverty and deprivation. Despite his disturbed schooling ; he could achieve multidiscipline educational understanding by dint of his high achievement motivation and great self-confidence. After having graduated from Saugar University in 1953, he obtained Post-graduate (1965) and Doctorate (1967) degrees in Psychology from Poona University. His Doctoral Thesis on 'Second Language Learning' was evaluated as an 'Outstanding piece of research, and was consequently published in 1977 under the scheme of 'Publication of Outstanding Educational Research' of NCERT, New Delhi. Hindi edition of his Doctoral thesis was also published in 1980 uuder the scheme of 'publication of learned work' of the Ravishankar University, Raipur. He has also obtained M.A. in Hindi (1956) from Nagpur University and M.Ed. (1959) as well as M.A. in Sociology (1969), both from Poona University. It is not only remarkable but also exemplary that 'Learning while Earning' is his philosophy of life ; and he acquired all these academic distinctions in the most adverse economic circumstances by something like a boot-strap effort.

Professor Sharma served as a school teacher for 16 years before joining Department of Experimental Psychology, Poona University, as a Research Assistant in August 1967. He was appointed Lecturer in the Department of Psychology, Ravishankar University, Raipur in November 1968, Reader in May 1979 and Professor of Psychology and Head of the Department in December 1983. He was Dean of the Faculty of Social Sciences of the Ravishankar University, Raipur during June 1984-June 1986. He has been twice (1982-83 and 1986-87) elected as Member of the Sectional Committee in Psychology and Educational Sciences of the ISCA. He is life member of ISCA as well as of Psycholinguistic Association of India. He is Secretary (Elect) of the IPA (1988-91) as well as of Psycholinguistic Association of India since 1971. He is Nominee-Member of Swami Pranavananda Psychology Trust of India since January 1982.

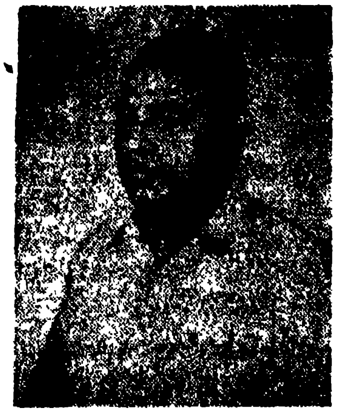
Professor Sharma is Founder-Editor and Editor-in-Chief of Psycho-lingua (1971) and has done pioneering work on Psycholinguistics; particularly on Second Language Learning. Anatomy of Creativity (1972), Cross-Currents in Examinations and Evaluations in India (1972), Psycho-linguistic Experiments in Hindi as a Second Language (1977) and Dwitiya Bhasha Hindi ke Manobhashki Prayog (1980) are the research-oriented books published by him in addition to one monograph on 'A Cross-Lingual Evaluation of Orthographical Errors in Hindi as a Second Language' (1980). He has also constructed and standardized six psychological tests and has published over 70 research papers in various foreign and Indian research journals, besides the publication of numerous articles, research notes and abstracts. He is the consultant in IPAT (Dehradoon), Indian Journal of Psychometry and Education (Patna) and Disabilities and Impairments (New Delhi).

Professor Sharma is supervisor for Doctoral researches in Psychology, Education and Home Science (CD) faculties of the Ravishankar University and is associated with numerous other Universities in various capacities. Fifteen Research Scholars have been awarded Ph.D. Degrees under his guidance. He has completed four research projects and organized two workshops on 'Research Methodology in Social Sciences' sponsored by MAPCOST, Bhopal and ICSSR, New Delhi; and a seminar on 'Laboratory Education in Psychology'. His research interest is evident from the fact that he has participated in more than 70 seminars/conferences/workshops/symposia organized in India in Psychology and Education.

Introducing, nurturing and nursing Psychology of Management in the Department of Psychology in the industrially developing area of Madhya Pradesh and instituting Human Resource Development Cell (HRDC) for Psychological Services and Consultancy with the main objective of bridging the gulf between the 'world of work' and 'world of knowledge', are the singular services rendered by Professor Sharma. His academic leadership to inter-disciplinary researches and his 'Learning while Earning' philosophy of life provide considerable inspiration to othets. □

Mr. H. B. Lal

President, Section of Engineering Sciences



H. B. Lal, C. Eng., P.E., was born on 9th February, 1927 in the Mithila region of Bihar. He took a B.Sc. in Engg. (Elecl. and Mech.) from BHU and M.Sc. in Elecl. Engg. from IIT, Chicago. Besides being an Hon. Fellow (equivalent to Ph.D.) of IIBM, he is a FIE(I), FSPE(I), MIEEE(US), MIEE(UK), MCIE (Can.) and is connected with several national and international bodies as Fellows/Members.

He started career as an Electrical Engineer in 1950 and, holding various posts between the Electricity Department of Bihar Government and the Bihar State Electricity Board, retired in 1985 as a Technical Member of the Board. He also worked in the United Kingdom with organisations like the Central Electricity Generating Board from 1960 to 1961. Besides achievements in all aspects of design, development, construction, operation and maintenance of electric power systems and their management, he created a break-through in rural electrification in Bihar electrifying about seventeen thousand villages. He was all through inventive and innovative and created many records.

He advocates that, to apply science and technology to improve the quality of rural life urgently, villages should be reduced in number, grouped each with about 5000 persons, reconstructed and resettled and integrated projects of reconstruction of each such village should be prepared for time-bound execution as a mass action. To support it logistically, he has established the "Rural Reconstruction And Development Institute, Patna". Similarly, to create a mass awareness and movement for the adoption of alternative energy sources he has also established the "Enegry-Ecology-Environment Institute, Patna". He is the founder Chairman of each of them.

He is a Rotarian. His hobby is reading, writing and constructive work. He loves music. He has authored several papers and participated in several national and international meets as author, co-chairperson and chair-person. His professional visits include countries like UK, USA, France, Germany, Switzerland, Italy, Algiers, Nepal, Bhutan, Malaysia and Thailand.

He has served and still serves on various bodies. To name a few, he has been in the Council of the Institution of Engineers (India) since 1980 and in the Senate of the Patna University since 1985. He was in the Indian National Committee of the World Energy Conference during 1983 to 1987. He represented India on the International Committee on "Availability of Thermal Generating Plants" during 1984-86 and was one of the six Indian representatives in the General Assembly of the "Federation of The Engineering Institutions of South And Central Asia" during 1984-85. He was the Chairman, Bihar State Centre of the Institution of Engineers (India), during 1983-85 and its Electrical Engineering Division during 1985-87. Currently, he is the Chairman of its Technical Activities Committee. He is also the Co-Chairman of the Board of experts of the "Engineering, Management and Consultancy Services, Patna".

To promote literary, cultural, educational and sport activities he has been connected with various bodies dealing with them. To name a few, he was the first President of Bihar Kumar Hindi Sahitya Sammelan, the Vice-President of Young Mens' Institute, Patna and the General Secretary of Vidyapati Parishad. He is the founder patron of Natya-Bharati and Vice-President of Aripan, dramatic organisations, the former of Hindi and the latter of Maithili. He is also in the editorial Board of the Hindi publications of the Institution of Engineers (India).

He is also a freedom fighter with ardent faith in socialism. As a student he was very active in Students Congress and in the implementation of the constructive programme of Mahatma Gandhi. In 1942 movement, even though he evaded incarceration, he worked ceaselessly with underground leaders and organised resources required for them. As the President and Member of the CEC of the Bihar Power Engineering Service Association, the founder Member of the EC of the All India Power Engineers' Federation and of the CEC of the All India Federation of Engineering Services Associations he has been a life long fighter for the prestige and position of engineers in administrative and social set-ups. ☐

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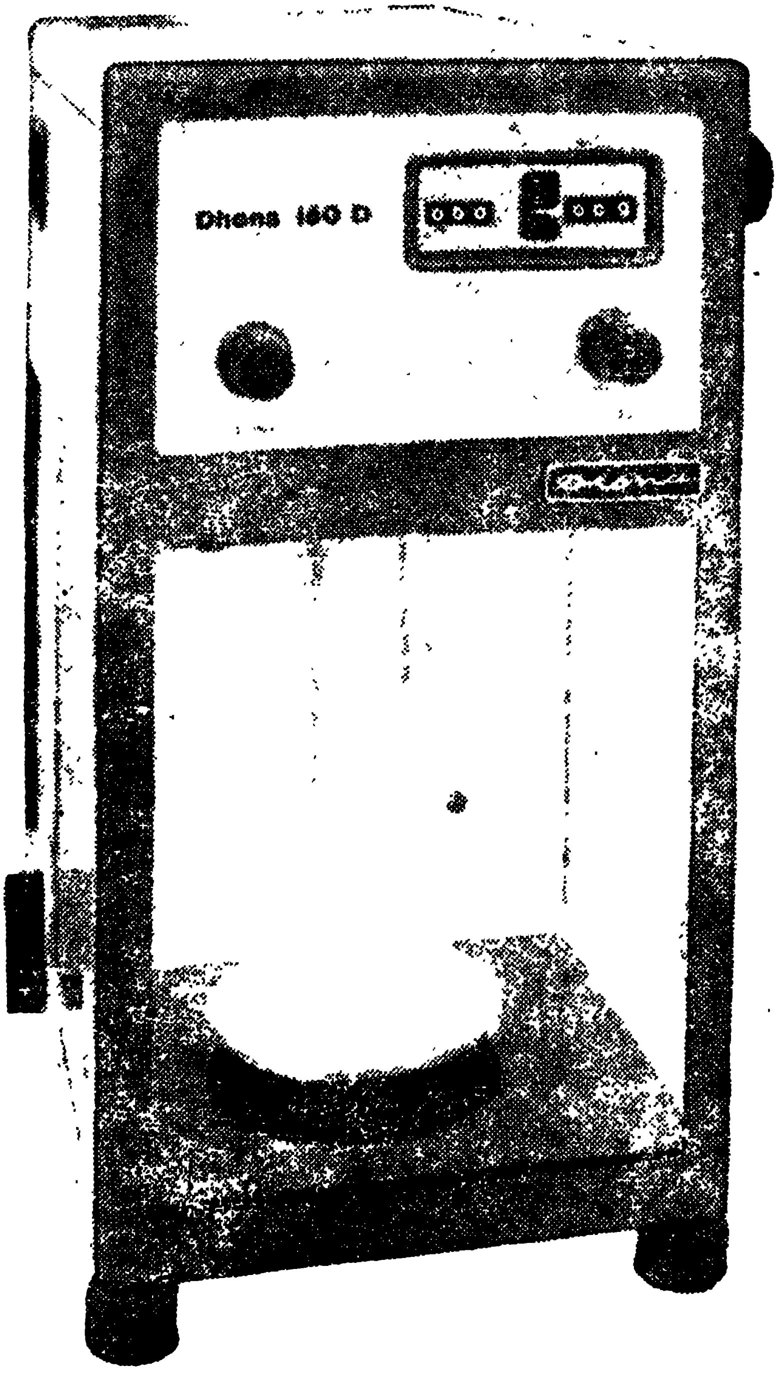

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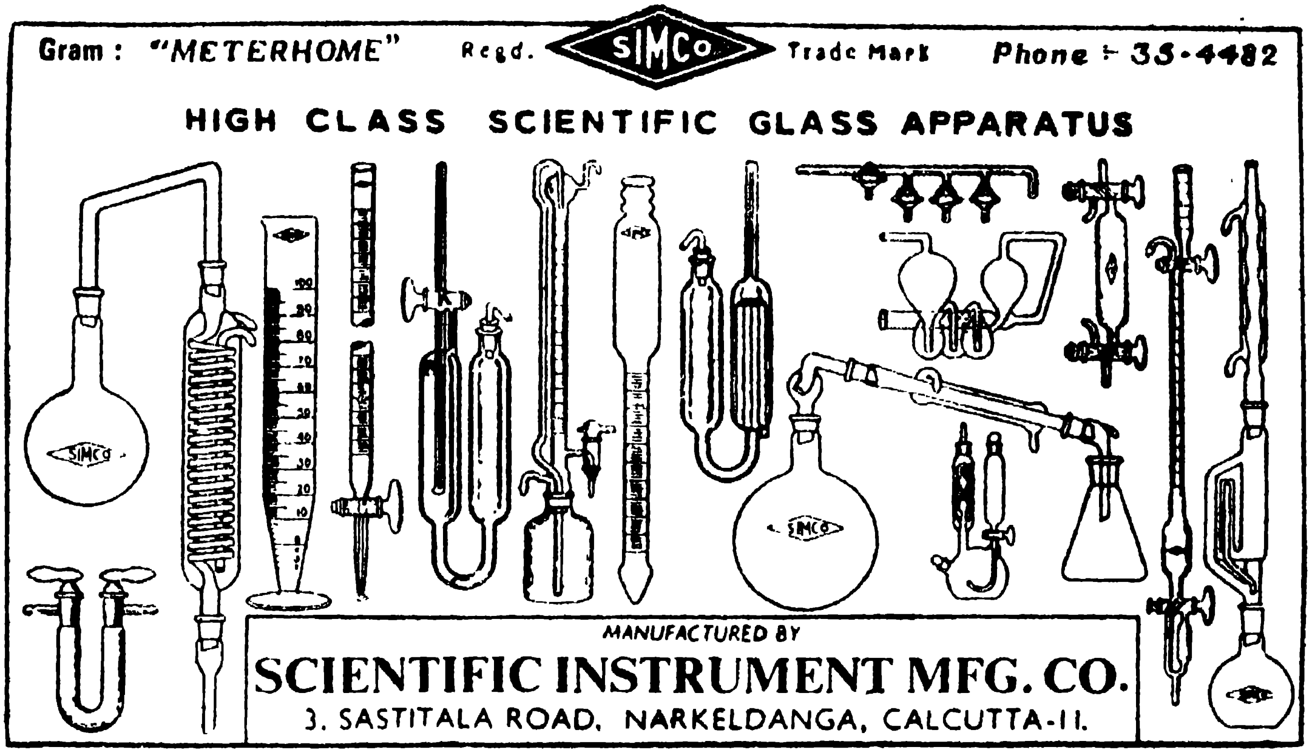
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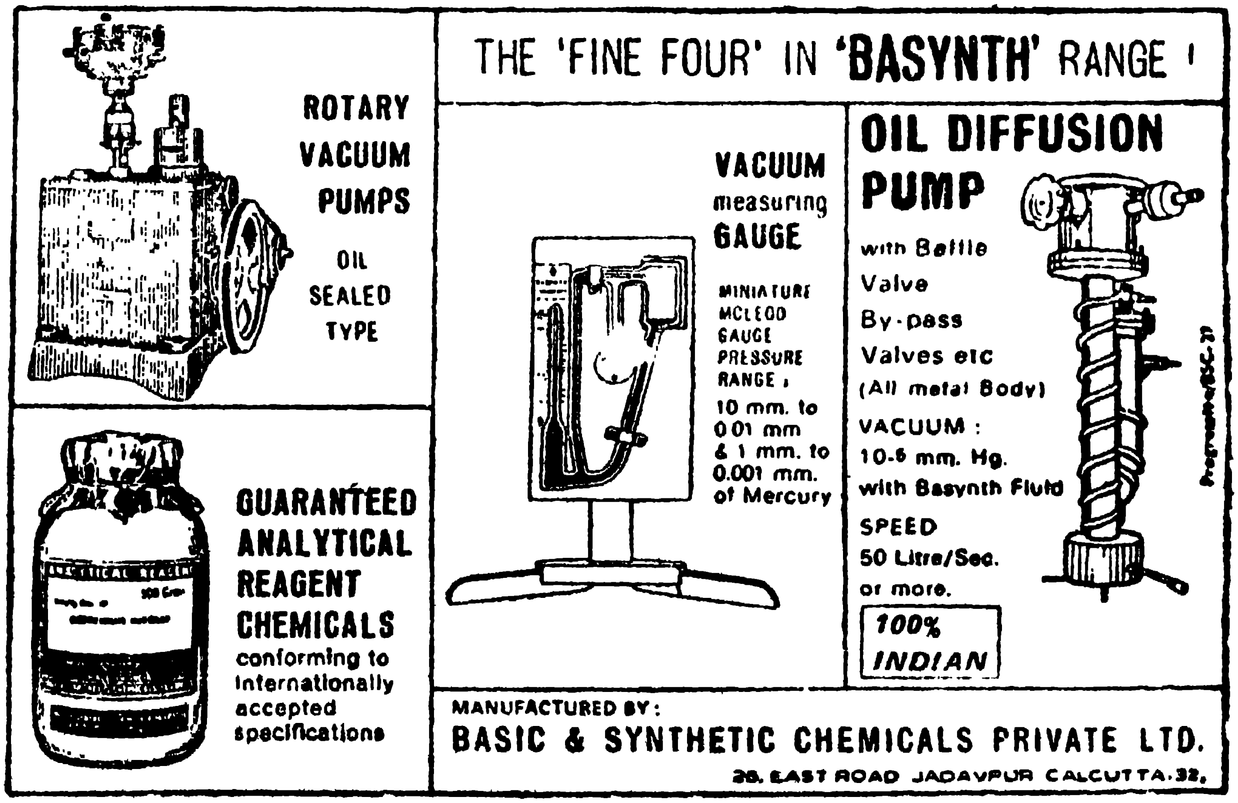
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SCIENCE & CULTURE

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A MONTHLY JOURNAL OF NATURAL & CULTURAL SCIENCES

PUBLISHED BY THE
INDIAN SCIENCE
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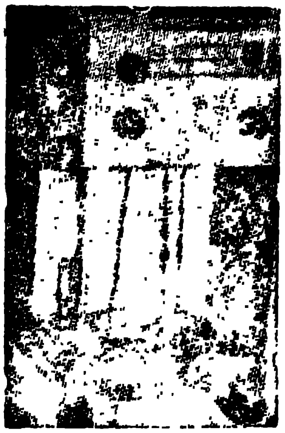

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SCIENCE AND TECHNOLOGY MISSION—THE INDIAN SCENE

EVERY year in the Science Congress we attempt an instrospection of our activities in the context of a special theme. In the last few years these themes included : frontiers of Science and technology, resources and human well-being, environmental priorities and sustainable development and several other areas.

In 1989 the focal theme was—Science and Technology in India—technology Missions. Dr. A. P. Mitra was the General President.

The conscious plan of organized scientific research in post-independent India and the imperatives of economic development and societal requirements have brought in the concept of mission mode operations of S & T activities. The missions, however, are to be considered in the broadest context and in the framework of our science and technology scenario. Missions can range from those which are primarily societal in nature to those which stretch the limits of our S & T capabilities. The single most important criterion is the harnessing of these capabilities to a specific, concretised, targeted goal and networking of component activities in a converging mode. Science can and should form a major part of these missions.

Basically there are three major types of Missions in the Indian context: (a) those which are essentially *societal*, where implementation and managerial elements are more important and S & T elements are generally limited to existing knowledge and practices, (b) *technological* missions where high level technological and scientific expertise are harnessed in a converging mode : here both technological and managerial inputs are important and sometimes innovative time targeted technological approaches are brought into play, and (c) *science missions* where scientific inputs far outweight the managerial inputs. In all these categories the element that separates them from other large programmes is the existence of one major specific goal to be achieved within a specific time frame. All these categories have to be encouraged.

Successful operation of missions require an adequate and appropriate R & D infrastructure. Such an infrastructure exists. The next step will need several important decisions :

- — to improve and expand R & D manpower substantially from our current inadequate level of 100,000 to perhaps 200,000 by the end of the 8th Plan.
- — to increase allocation for R & D from 1 per cent to over 2 per cent of GNP in perhaps a time frame of about 5 years.

- to assign an appreciable proportion of this total allocation to industrial R & D.
- to ensure increase in Industry's own investment in R & D, encourage symbiotic relationship between industry, university and research laboratories, and
- to ensure selectivity in the choice of technologies in which we can be internationally competitive.

The principal mission imperatives are :

(a) involvement and commitment, (b) mission leadership entrusted to scientists and technologists, (c) ensuring that emphasis on management does not detract technological content, (d) milestones and evaluation strategies clearly specified. No mission works without involvement of all sectors of participants. Management is effective only if there is a good deal to manage. One needs also to ensure that young scientists and technologists are called upon increasingly to head such missions

To bridge a century's technological gap is not to follow others rung by rung, but pursue one's own efforts in the forntiers of knowledge. Examples like the Ooty radio telescope show that it is not always necessary to go through intermediate scales.

There is adequate scope for undertaking serious scientific investigations in missions currently on, even if they are classified as societal missions. For instance, in the mission on drinking water, S & T inputs are required for improved techniques for detection of underground water in hardrock areas, development of water treatment plants of various kinds and a long term estimate of the changing pattern of rainfall in the context of global warming. In the mission on telecommunication, work related towards the attainment of Integrated Services Digital Network (ISDN) integrated in a compatible way, voice data and video services, and using a combination of fibre optic cables, satellite links, coaxial cables, wireless and radio links and radio communication extending to millimeter regions, use of the MST radar on a national scale, once it is installed, as critical input in atmospheric probing, frontier level possibilities in the design, fabrication of VLSI or embryo transfer technology or biotechnology in industrial processing.

A positive step towards a better future would be to take up a number of science-based major programmes in mission mode, thus getting the country prepared for technology or societal missions with a fairly good science content. One such programme is the International Geosphere-Biosphere Programme (IGBP), with global implications, concerned with documenting and predicting global changes and their consequences in the next few decades. Another is the National Standards and Calibration Programme with the National Coordination of Testing and Calibration Facility (NCTCF) allowing testing and calibration down the line to consumer level and providing the critical base for quality assurance of industrial products. The third one relates to development of advanced materials : one example is advanced ceramics, an emerging technology in which we have a reasonable chance of being competitive.

Mobility of scientists from one organisation to another and through academic institutions, national laboratories, industry and mission management units has been talked about but cannot be implemented effectively because of non-uniformity in salary structures, a multiplicity of rules and different lien conditions. A national group should examine and recommend a viable system. ☐

P. K. Bose

SCIENCE AND TECHNOLOGY MISSIONS : THE INDIAN SCENE

A. P. MITRA

I am most grateful to the Indian Science Congress Association for electing me to the Presidentship of this organisation for this year and to the Madurai Kamaraj University for organising this Congress in this famous temple town and in one our finest Universities. In this annual science gathering—the largest such gathering in this country—we have been fortunate in having the Prime Minister inaugurate on most of the earlier occasions. We are grateful to Shri Rajiv Gandhi for doing so this year also.

This Congress is being held at very special time. Prof. C. N. R. Rao, the immediate past President, pointed out last year the most unusual feature of the present time in the history of science of India ; the confluence of three special centenary years—that of the great mathematician Ramanujan in 1987, one of India's greatest experimental physicists Prof. C. V. Raman in 1988 and the celebration of the centenary year of Pandit Jawaharlal Nehru in 1989. The present high level of science in this country owes a good deal to the efforts of these three great men.

Nehru was associated with science Congress since 1942. He was the President-elect of the Congress in 1943 and the President of the Congress in 1947. As the President-elect for 1943, he was to preside over the Congress in Calcutta but could not do so because of his internment in the Quit India Movement of August 1942. His Presidential address in 1947 was remarkable in many ways. I would like to quote here a small paragraph of that address :

> "For a hungry man or a hungry woman, Truth has little meaning. He wants food. For a hungry man, God has no meaning.... We have to find for them clothing, housing, education, health and so on—all the absolute necessities of life that every man should possess. When we have done that we can philosophise and think of God. So, science must think in terms of the 400 million persons in India".

This is a special time for another reason. India has reached a state of scientific excellence that can lead to a technological revolution with a little bit of extra effort. We cannot let this chance slip away.

R & D Structure in India

Generation and deployment of resources in India have indeed leap-frogged spectacularly from 1950 to now. Universities have increased about ten fold, general S & T personnel from 2 to 30 lakhs, specialised national laboratories from a few to over 300, and R & D investment from Rs. 20 crore in the 1st Plan to about Rs. 10,000 crore in the 7th Plan. R & D expenditure as a percentage of GNP has increased from 0.01% to 1%—by a factor of 100. An important change has been the emergence of R & D centres within the industries—currently there are 1050 of these, engaging about 45000 people and involving expenditure of about Rs. 600 crore a year.

We are, therefore, talking about a vastly changed scenario. Although most Western countries spend 2-4% of GNP on R & D, the amount spent in India is nevertheless large and is likely to be considerably more in the 8th Plan. There are two limiting factors in the scenario : (a) the fact that of the 30 lakh S & T personnel only 1 lakh (or about 3%) are really available for R & D work in contrast to 30,000-500,000 in West Germany, Japan or the USA and (b) the distribution of Rs. 10,000

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*Excerpts of his address as the General President at the 76th session of Indian Science Congress, Madurai 1989 crore is uneven. The amount available for universities, though not adequately quantified, is no more than 5-6% and for entire areas of health and agriculture no more than 10% of the total investment. Also funding of R & D efforts is 60-70% from Industry in most developed countries whereas in India it is than the total investment on R & D. R & D investment in industry is currently too low, not only in relation to developed countries but also to countries in South East Asia like South Korea, Taiwan or Singapore.

The first major step of building a sound base of science and technology from a predominantly non-industrial society has been taken. The next step for achieving international competitiveness will need several important decisions:

(i) to improve and expand R & D manpower substantially from our current inadequate level of 100,000 to perhaps 200,000 by the end of the 8th Plan.

(ii) to increase allocation for R & D from 1% to over 2% of GNP in perhaps a time frame of about 5 years,

(iii) to assign an appreciable proportion of this total allocation to *industrial* R & D,

(iv) to ensure increase in Industry's own investment in R & D, encourage symbiotic relationship between industry, university and research laboratories, and

(v) to ensure selectivity in the choice of technologies in which we can be internationally competitive.

Individual vs Organized Science

This conscious plan of organized scientific research ("big science") in contrast with the pre-independence era of individual efforts in science has brought in totally new dimensions of science management, performance and evaluation, and also gradually the emergence of "mission" mode operation. In agencies like Atomic Energy and Space, specific long-term major goals (10 year profiles) have always been defined and action plans concretized and time-targeted. Much of the successes of these agencies are attributed to such "mission mode" approaches.

INSAT 1-B and the recently launched Indian Remote Sensing Satellite IRS 1-A are excellent examples of successful missions. The first has brought in a virtual revolution in communication through a total of 74 receive/transmit telecommunication terminals providing some 4000 two-way telephone circuits, 100 unattended meteorological Data Collection Platforms, a fleet of 100 Disaster Warning Sets, a national TV service covering some 250 TV stations and an imaginative standard time and frequency signal dissemination system. The second carrying three cameras to image the earth from a height of 900 km is providing pictures of remarkable resolution and will add to the capabilities of several national and state level user agencies which have in the past been using data from USA Landsat and NOAA satellites and the French SPOT satellite. The 13 MWe Fast Breeder Test Reactor at Kalpakkam which attained criticality in October 1985 but was conceptualised 10 years earlier is another example : more so, since all important components were built within the country.

"Mission mode" approaches have also been used in fundamental science programmes. The best known amongst these is the International Geophysics Year (IGY) Programme conducted some thirty years ago. Thus missions vary in objectives and in S & T content. Basically there are *three* major types in the Indian context : (a) those which are essentially *societal*, such as drinking water or immunization programmes where implementation and managerial elements are more important and S & T elements generally limited to existing knowledge and practices, (b) technological missions such as the launching of the IRS satellite or the successive Antarctic campaigns where high level technological and scientific expertise are harnessed in a converging mode : here both technological and managerial inputs are important and sometimes innovative time targeted technological approaches are brought into play, and (c) science missions such as IGY, IMAP, the Ooty radio telescope where scientific inputs far outweigh the managerial inputs. In all these categories the element that separates them from other large programmes is the existence of one major specific goal to be achieved within a specific time frame. The goal may be specific services (such as providing potable and safe drinking water in a specific number of locations or the ATS-6 satellite campaign in the seventies providing a direct broadcast TV to distant villages), or specific hardware (such as the Ooty radio telescope set up some twenty years ago or the ARVI satellite receiving station) ; or a special campaign (such as the series of Antarctic programmes) ; or a very well defined time-targeted scientific effort such as IGY some thirty years ago or IMAP currently on or the new programme on superconductivity.

A major criticism of the "mission mode" approach is that of inhibition of creativity and of individual excellence. The argument here is that while the pre-independence era had individual peaks but a relatively low base of science and technology and thus was lopsided in one way, it is no reason that we should now go to the other extreme of organized mediocrity. There must be scope for bright minds to chart their own courses even in institutions committed to mission mode operation.

We have, therefore, two goals : one goal is to raise the background level of S & T competence across the board and to nuture individual visionary paths, and the second is to have time-targeted, goal-oriented large programmes of preset activity elements.

The two are not necessarily in conflict. Obviously, one complements the other. One cannot undertake major programmes, whether goal-oriented or open-ended, if the baselevel is not high. The baselevel cannot be high if visionary open-ended programmes are not encouraged or longterm commitment is not available. The current excellence in superconductivity would not have been possible if there had not been decades of continuous open-ended programmes in low temperature physics and in material science in several institutions in India. Desalination programmes have been going on for many years before the water mission was taken up.

These two streams should co-exist in any agency. A good mission is one that can attract real scientific attention, and this will happen only if the two streams are combined.

Scientific Missions in the Past

I would like to discuss now two specific science and technology missions that we have successfully operated in the past and point out the lessons that one may learn. For this purpose I choose programmes I have been particularly familiar with, and these are : (a) the International Geophysical Year Programme of 1957-58, and (b) the SITE programme in the mid-seventies.

IGY :

The International Geophysical Year, or IGY, was perhaps the first organised entry of Indian science into international arena. The programme was intially for the period 1957-58, but was later extended to 1959. The target was a global description of the entire earth system—the solid earth, the oceans, the atmosphere and various forces acting upon these, ranging from electromagnetic radiations and particles from the sun to the cosmic rays.

IGY was a remarkable event. It brought in a great change in Indian science in several areas—in ionosphere, in cosmic rays, in geomagnetism, in solar physics, in meteorology and in many areas of earth sciences. A total of 64 countries eventually joined the programme involving some 2500 stations and the labours of some thirty thousand scientists and technicians.

The special role played by the region near the geomagnetic equator was already known. In that context, India had a special significance. Trivandrum was almost exactly on the magnetic equator, Kodiakanal on the fringe of the electrojet, Tiruchirapalli in the middle of it. Further north Ahmedabad and Calcutta were nearly at the peak of the Appleton Anomaly and located (excepting Calcutta) all nearly around the same longitude. 75°E, an unusual advantage that was immediately recognized.

Furthermore, IGY was a poor man's programme, Irrespective of the scientific level of the country or of the institutions, there was scope for useful contribution from all. Some of the observations could be undertaken with relatively simple instruments, such as : the reception of signals from broadcast transmitters or atmospherics in the LF and VLF, experiments on atmospheric electricity, meteorological observations with groundbased sensors or with radiosoundes that were being undertaken in any case as part of the country's weather service, photography of auroras with simple cameras on the ground, the simple telescopic arrangement introduced, after Sputnik I was launched, to obtain approximate positions of an orbiting satellite in the programme called 'Moonwatch".

It was realised that a description of the earth and its atmosphere could only be achieved if the observation stations were carefully distributed. The number of Indian stations was over 100, one-third of all Northern Equatorial stations and the number of scientists participating were a few hundred consisting of people not only from highly sophisticated institutions and agencies but also from small colleges.

We have recently had occasion to evaluate the achievements and impact of this programme looking at from today's viewpoint. It is remarkable how much was achieved—some achievements were worldclass, such as the introduction of the riometer, a new technique in which the radio noise from the galaxy is used to explore our ionosphere, the extensive radio flare patrol system introduced, one of the first atmospheric density models derived from observations of satellite drag and most importantly the young scientists actively participating in the programme led Indian science in these areas for the next three decades.

IGY saw the beginning of space age. It also changed almost entirely our concept of the earth-atmosphere system. With the discovery of Van Allen Radiation belts and of the deformation of the earth's magnetic field by solar winds, the earth system looked like a comet with an extended tail of trapped particles away from the sun. The upper boundary of our atmosphere which till then was believed to be around 300 km, moved to several earth radii. Indian scientists were active participants in the adventure and shared all the excitement. The Thumba rocket range and the Hyderabad balloon facility were established as a result of these activities, and Indian space research began in right earnest.

THE SITE PROGRAMME :

The next "mission mode" programme I would like to talk about was that connected with ATS-6 satellite in the mid-70's. There were two major programmes : one relating to direct reception of TV signals by about 2330 villages in six widely separated direct reception clusters and the other a planned network of satellite radio beacon receiving equipment operating in different parts of India at one or more designated frequencies : 40, 140, 360 and 860 MHz. The direct broadcast satellite programme (known as SITE) was a unique experiment conducted jointly by ISRO and NASA of USA under the agreement between the two countries for a duration of 12 months from August 1975 to July 31, 1976. The primary purpose was to bring TV to backward and remote villages of India through direct reception of signals from the satellite. Over 1200 hours of programme needed for the experiment was in fact more than the annual feature film production in India. Programmes were broadcast 4 hours every day ; the subjects included family planning, agriculture, health and hygiene. The prime earth station was located at Ahmedabad, linked to a TV studio which in turn was connected to a VHF transmitter at Pij, 50 km from Ahmedabad. Progrmmes were sent to the satellite on 6 GHz band and were then retransmitted by the satellite at 860 MHz with a 30 ft. antenna having a pointing accuracy of ± 0.1°. Other earth stations were at Delhi and Amritsar, connected to VHF transmitters of AIR. Each village receiving system consisted of : (a) a chicken mesh dish of 10 ft. diameter, (b) a front end converter which converted the VHF signals to video and audio. Both were designed and developed by ISRO and manufactured by ECIL. The earth stations were also designed and assembled within the country.

The experiment was successful both scientifically and socially. One of the many examples of its success was the Republic Day parade telecast on January 26, 1976. On this day the satellite network included all Doordarshan TV stations. The result was that for the first time people in Delhi, Calcutta, Bombay, Pune, Srinagar, Lucknow, Khera and 2330 villages saw the parade in real time.

While the SITE programme was operationally an exciting adventure, the second aspect of the ATS-6 programme—the satellite radio beacon experiment—was also scientifically exciting. ATS-6 was the first geostationary satellite available to a wide community of Indian ionospheric scientists. Its coverage of frequencies extending from 40 MHz to 860 MHz offered scope for study of the frequency effects in scintillation, including those at the frequency of 860 MHz, then considered too high for ionospheric effects. An extensive network of stations could be organised involving the National Physical Laboratory at Delhi, the Physical Research Laboratory at Ahmedabad, Vikram Sarabhai Space Centre at Thumba, the Radio Astronomy Centre at Ooty, and a number of Universities including Patiala, Kurukshetra, Delhi, Udaipur, Calcutta, Saurashtra and Andhra. All these stations were located around 75°E longitude and the coverage extended from geomagnetic equator to about 27°N geomagnetic latitude—an unusually attractive range of latitudes for the study of low latitude phenomena, especially ionospheric scintillations that are known to be particularly severe in the equatorial belt. Another special feature was the availability of the Ooty telescope for measurement of scintillation of selected radio stars in the same time frame.

What are the lessons of these two missions—so spectacularly successful ? IGY was not called a mission, but for all practical purposes it was one and the investment was so little. One might think it strange now that a programme of many hundred scientists, more than a dozen universities, many colleges and national laboratories was led by a few of us in NPL, then in late twenties or early thirties, occupying relatively junior scientific positions—and (even more strangely) were listened to, not only by the participating scientists, but government departments generally considered rigid. The second point was the attention to detail and timeliness ; observations all over the world were to be taken simultaneously in a predetermined schedule. Quality was ensured with initially prepared guidelines and special intercomparison efforts. But perhaps the most important element was that the Programme Directorate was not merely a management system but had its own scientific programme forming a major and well-regarded part of the mission.

For the SITE programme, the success was astonishing. Here was a programme involving scientists, technologists, social scientists, technicians, school teachers, village workers, production agencies orchestrated as a programme of magnitude then unknown in India except in single agency missions, along with a side programme of satellite radio beacon experiments involving quite a different group of scientists again spread over the country. It is difficult to pin-point the reasons for success : certainly the managerial skill was excellent and the programme was exquisitely planned. To me the most important factor was the involvement. It was *our* programme : a programme of the participants whatever their role, and the programme details were *evolved* and not *imposed*.

The most rewarding consequence of these two "missions" was the growth of scientific and technical talent now leaders in science in ISRO, in TIFR, in national laboratories and a number of universities.

Missions now in Progress

I will now select a few of the currently operating missions : (a) the Indian Middle Atmosphere Programme (IMAP) in progress since 1982, (b) the first Indian Scientific Satellite mission SROSS Aeronomy Satellite now under implementation, (c) the Mesospheric Strato-spheric—Tropospheric Radar (MST Radar) for which design efforts have been completed and construction activities have begun, and (d) the Drinking Water Mission. In addition, I will bring up the matter of recent telecommunication revolution in the world, in the context of our own telecommunication mission.

IMAP :

IMAP, the Indian Middle Atmosphere Programme, started on January 1, 1982 and is currently to terminate on March 31, 1989. In this programme the thrust is on a relatively narrow part of the atmosphere, from about 10 km to 90 km, stretching between the tropopause and the mesopause. Attention has, in recent years, been dramatically focused on this region with the increasing realization of the frail nature of the stratosphere (subject to catastrophic change through human influences) and its possible role in providing the coupling between the variable solar UV flux and the lower atmosphere. The single most important constituent is ozone, providing both a screen for biologically hazardous UV-B radiation, and, through "greenhouse" action, a modulation of the heat budget. But ozone variations are linked with variations in a number of other constituents. Much of these emanate from the surface (methane from biomass burning and from paddy fields ; carbon dioxide from fossil fuel and biomass burning, NOx from forest fires, etc.). There is also a multiplicity of sources, natural and anthropogenic (*natural* : solar protons, volcanic eruptions, lightning discharges, *anthropogenic :* biomass and fossil fuel burning, aerosol sprays, spacecraft effluents, nitrogenous fertilizers). From the massive research activities mounted in the seventies on the ozone problem, it became clear the many of these minor species add to the greenhouse effect of CO_2 by a factor as high as 80% and are, therefore, climatically important. Since much of the natural source comes from the equatorial regions (paddy fields, biomass burning) the importance of such studies for the equatorial areas like India was obvious.

Indian interest in this programme also arises from several excellent facilities that now exist in the country and the role of the middle atmosphere in monsoon circulation and atmospheric chemistry. Some special aspects are : (i) availability of 3 rocket ranges: Thumba (9°N), SHAR (14°N) and Balasore (21°N) ; (ii) availability of a national balloon launching facility at Hyderabad, and (iii) a dense network of radiosonde stations of IMD and its continuing operation of key experiments : (a) ozone measurements with Dobson spectrophotometer and balloon-borne sensors (b) atmospheric turbidity measurements in 10 stations.

A point of special concern is that much of India is a region of low ozone content, and, therefore, biological consequences in case of depletion are more serious.

The Indian programme that has been organized involves the participation of some 200 scientists (at least 50 of them are young scientists in the thirties and twenties). The young scientists whose initiation in earth space environment programme occurred during IGY are now leaders of IMAP. There is direct involvement of seven agencies (DOS, DST, CSIR, UGC, DOE, DOEn, DTCA), several national research institutions and 11 universities. The programme is managed through three parallel systems : the Interagency Board consisting of representatives of the funding agencies, the Project Management Board which implements the programme and the Scientific Advisory Committee which provides continuous scientific inputs to the programme. The last ensures changes in the scientific content where necessary.

What have we achieved ?

A major aim was to evolve a first order reference middle atmosphere over India. An International Tropical Reference Atmosphere has been developed. Measurements on ozone have been the most extensive, involving essentially all known techniques and also special joint campaigns with the USSR. Water vapour, methane and Chlorofluorocarbons have been derived from balloon-borne measurements. The station at Dakshin Gangotri in the Antarctic detected the presence of ozone hole over the station even though it is located on the fringe of the "hole" region. Efflux of trace species of greenhouse interest resulting from slash-and-burn agriculture was monitored. Conductivity of stratosphere was found to be perturbed when dust particles from volcanic eruption reached the Indian subcontinent. Disturbances in ozone profile were detected following weather disturbances.

New technologies emerged out of the programme : a lidar facility was set up at Thumba capable of real time profiling of aerosols upto about 25 km. A laser heterodyning system was set up at NPL giving profiles of water vapour and ozone—a remarkably powerful technique. A byproduct of IMAP was the decision to set up an MST radar which we will discuss later.

SROSS SCIENCE MISSION :

The SROSS Aeronomy satellite is a mission of another type. This will be the first Indian all-science satellite mission : all the scientific payloads are Indian (from the National Physical Laboratory at New Delhi and the Physical Research Laboratory at Ahmedabad) and the satellite is Indian using ASLV Launcher. This is a 150 kg class Satellite earmarked for the upper atmospheric experiments. Payloads are being designed and being fabricated by NPL and PRL. The apogee is 550 km and the perigee, 400 km. The main objective is to look at the peak region of the low latitude ionosphere and see how the neutral and ionised atmospheres are linked with sources that heat the region and produce motions.

It is important to note that while the mission was conceived in 1983, it took two years and a large number of scientists, technologists and engineers to fully define the mission specifics. Experiments were invited from all interested groups in India, but then these went through very serious and detailed evaluations and only two-thirds of the originally proposed experiments survived. The design details were frozen only after a further peer review a year later in 1986 when a breadboard model was fabricated. The pre-engineering model was completed in 1987. Actual launch is expected in late 1990 or early 1991. Thus it took 3 years to design the experiment —about as long as it will take to complete the fabrication. Attention to details is agonizingly thorough. While the fabrication is going on, scientists are simulating the results through computers or examining experiments elsewhere in the world for last minute changes or arranging for interim test rocket flights. A special danger for programmes with such large gestation period is that scientific imperatives change. It is important, therefore, that in designing experiments of this kind a futuristic projection is built in. A mission of this kind is possible only because a vigorous satellite launching infrastructure is available and competent space science groups have been nurtured for over two decades.

MST RADAR :

MST radar is a mission of a still different kind. Here we are planning to build a very large state-of-art high technology facility of world class using our own design and our own technology groups. The design has been made by scientists from NPL, PRL, VSSC, TIFR and several universities and went through various processes of iteration over several years. The construction and installation job has been given to SAMEER, a microwave engineering group that began in TIFR.

MST radar is a high power, pulsed doppler radar operating in the VHF, capable of exploring the atmosphere from surface to about 90 km, covering the troposphere, the stratosphere and the mesosphere. It is a new generation radar of immense potential for continuous atmospheric probing in a three-dimensional form. The Indian MST radar will be located at a place called Mittagadanki (13°N 79°E) near Tirupati, not far from the rocket range SHAR—an added advantage providing possibilities of intercomparison and intercalibration. The radar will operate at a frequency of 53 MHz with peak power of 2.5 MW and an average power of 60 kW. The antenna system is an array of 1024 yagi elements spread over an area of 136 m × 136 m covering an area as large as 1.8 sq. km. The radar is expected to operate on ST mode (stratosphere-troposphere mode) by 1990 end and MST mode by 1991. It will operate as a national facility providing major opportunities for atmospheric research to Indian aeronomers.

To many, MST radar heralds a new age to atmospheric physics much the same way radiosondes were decades ago. In the USA the technique is beginning to be used operationally for tropospheric weather prediction. One major reason is that it is the only instrument that can observe under all weather conditions, and can sample the atmosphere at short time intervals.

There are exciting possibilities : detection of events occurring on short spatial and time scales, capability to locate atmospheric fronts, ability to detect echoes from precipitation particles as much as from refractive index irregularities, real time use of wind profiles in nowcasting in regular use in the USA, ability to monitor gravity waves and turbulence induced by the momentum flux, observations of thunderstorm reflectivities, the capability to monitor the behaviour of the tropopause breaks and to locate the breaks relative to fronts. In the Indian context, what advantages will accrue in the study and understanding of monsoon dynamics is not immediately clear, but one should be able to monitor changes in circulation patterns of interest.

MST radar is another example of an interagency mission with totally Indian design and fabrication assigned to an Indian research group.

THE TELECOMMUNICATION REVOLUTION :

In a recent conference on the future of the International Scientific Radio Union held in Corsendok, near Brussels, Professor W.E. Gordon termed the present communication revolution as the " 0th Century Gutenberg". He was referring primarily to video communication—a combination of satellite links, television, fibre optics and high speed information transmission. The societal impact of this combination has already had an influence greater than that introduced by printing through the Gutenberg Bible 500 years ago. This printing, we now recognize, was a crucial invention in man's history ; and since it was made there, it gave to Europe power and influence for centuries. It was, in his view, linked with the other European event, the Reformation, and gave rise to the phenomenon known as Renaissance. Prof Gordon went further : he considered the introduction of video communication a step bigger than Gutenberg's printing press.

One indeed marvels at the explosive growth of telecommunication in the last few decades. It was less than ninety years ago in 1901 that Marconi succeeded in transmitting signals from England to America over the intervening bulge of the Atlantic Ocean ; our own pioneer Jagadish Chandra Bose sent a radio signal in the Presidency College, Calcutta, from one room to another in 1897. Satellite communication emerged only three decades ago but has changed telecommunication of the eighties totally. Laser and optical fibre cables are only decades old. The physical limits of integration on the silicon chip have not yet been reached.

As was mentioned before, we have now a dizzy combination of several modes of telecommunication. They are : the decades-old HF/MF communication, finding a new life through the concept of Realtime Channel Evaluation (RTCE) and still covering 90 per cent of developing world's telecommunication ; satellite links—a revolution having taken place in India through national networking using INSAT system ; television—a late starter in India but a disturbingly potent social force ; fibre optics (still rather new in this country) and highspeed information transmission.

What is the future of this combination ? It is generally agreed that telecommunication in 1990s would surely use digital networks with computers as elements of the network and as terminal equipment. Such networks would integrate in a compatible way voice, data, and video services and use a combination of fibre optic cables, satellite links and microwave links in high capacity networks. The low capacity circuits would involve satellite links, coaxial cables, wire lines and radio links. The backbone would be the Integrated Services

Digital Network (ISDN). There is a difference of opinion on the role of satellite links vis-a-vis fibre optic cables. While some believe that future networks will be exclusively based on optical fibres, others point out that for small capacities, satellite communication is cheaper and lighter to instal than optical fibres, even for moderate distances.

The same approach is envisaged for a boardband network, i.e. each subscriber has simultaneous access to several network channels offering different services such as access to TV or Hifi programmes, telephone, radiophone, data service—all controlled by a common signalling channel This is the kind of network currently being discussed in different forums and is believed to be the future basic communication network in the next century.

The heart of the future system would be the optical fibre. The present optical fibre communication is in a sense as primitive as radio communication was before 30's. Both did not use phase information of the carrier i e. both are non-coherent communications. Neither frequency conversion (heterodyne or homodyne) nor sophisticated signal processing at lower frequencies is effected. In radio communication heterodyning scheme was introduced in 1930 and is now used even in simple receivers. A similar question came up in the 1970's about optical communication. The currently used Intensity modulation/direct detection (IMDD) system is simple and economical. On the other hand in programmes such as under-water optical fibre communication where long repeater separation is the major concern, one considers the possibility of improving the equivalent receiver sensitivity by a heterodyne type receiving technique or by a coherent modulation/demodulation scheme. Good photodetectors for direct detection are not available 1.5-1.6 μm region where silica fibre loss is minimum (0.2 dB/km). This was the impetus for introduction of heterodyne/coherent optical fibre detection initially in Japan, but later elsewhere in the world.

Twenty years back, in the sixties, it almost looked as though propagation through the ionosphere (3-30 MHz) primarily was a nuisance and would eventually be replaced.

Radars were moved to frequencies above 400 MHz wherever possible to avoid ionospheric problems. Satellite communication services were placed in the 4 and 6 GHz region partly to avoid ionospheric problems and partly to avoid problems to troposphere. It soon become clear that ionospheric radio communication would continue to stay for quite some time. This was for several reasons. First, a new type of radar—"over-the-horizon" radar—was introduced using very weak ionospheric scatter for its effectiveness in long distance reconnaisance of distant terrestrial objects. The other application of a similar system for distant monitoring of sea waves also became an effective tool. It is also recognised that one can artificially modify the ionosphere by high power radio-waves sufficiently strong for a variety of purposes. This is one side of the picture—a new type of need for the ionosphere as a medium. The other side was that demands on precision and accurate identification with a new radar system were becoming more and more stringent. This needed a better estimate of ionospheric time delay. Also the use of high data base in satellite communication meant that one should be able to estimate adequately loss of data base through fading produced by ionospheric irregularities.

When one goes to tropospheric propagation, the current and future trends appear to extend communication into millimeter wavelengths (30-300 GHz), still relatively uncrowded. The trend is also on the characterisation of the medium with a much higher precision. There are several parameters of the medium that are important ; ducting, turbulence, rain. Rain is a particularly important parameter and has been so recognised for over four decades for frequencies above 5 GHz. One should have information characterising statistically the temporal and spatial structure of rain. Dual-polarisation radars have been in use for some time. New techniques are under development. One involves remote sensing of precipitation from space. Another is the simultaneous use of a number of links at various frequencies to provide a data base. Additionally data base is necessary on absorption by water vapour and oxygen, Cost-effective wide bandwidth communication in this region will utilize atmospheric "window" regions. Communications requiring security can utilize frequencies like 60 GHz where 97% of the signal is attended at a distance of one kilometer.

While telecommunication is one of the technology missions, much of what I have described here is beyond the scope of the short term objective of this mission. Nevertheless in subsequent phases some of these will have to be incorporated. The present state of optical fibres and cables in the country is still inadequate ; the major research groups are in some of the national laboratories including the Central Glass and Ceramic Research Institute and a few IITs. Two collaborations have been entered into—one by Madhya Pradesh State Electronics Development Corporation and another by Hindustan Cables Limited. Both will use production equipment to draw optical fibres from preforms made by MCVD (Modified Chemical Vapour Deposition) technology but their linkages with R & D institutions need to be ensured.

India has a long and distinguished record of ionospheric research and is able to support ionospheric communication systems effectively. In microwave and millimeter propagation systems while much work has already been achieved, the critical need is of characterisation of the medium with better time and spatial resolution than currently available. Rain is a particularly important parameter for countries like India for frequencies above 5 GHz. In India the only improvement that has occurred over the age-old bucket-type rain measurements is the introduction of rapid response rain gauges several years ago at NPL and later elsewhere and a few links in GHz range But radar based information in quantitative terms is not available In the context of recent major developments in radar systems in India, such studies can now be mounted.

DRINKING WATER MISSION :

There is scope for some serious science in the drinking water mission. S & T inputs are required for (and have to some extent been provided in): development and use of techniques for the detection of underground water, development of suitable water testing field kits at various echelons, development and production of water treatment plants of various types (for desalination, for iron removal, for removal of fluorides etc.), development of chemicals to retard water evaporation and techniques for conservation of water. As in most societal missions, a good deal of the effort is basically non-scientific and relates to the implementation strategies and management procedures. Nevertheless, in this mission there is a good scope of a mixture of current and future technologies and a mixture of simple and complex techniques. Take, for example, the question of scientific source finding. Here we need to combine the remote sensing satellite imagery with ground-based geoelectric and other soundings : the first provides large lateral scale pictures but with small depth ; the other provides more localised samplings and large depths extending upto several hundred metres. If the ground truth is linked effectively with satellite imageries, then together the success rate is found to increase to 92%. There is scope of considerable work in assessing the relative advantages and disadvantages of several ground level water resource finding techniques. The electrical resistivity method is fast, economical and detects water down to 100 m ; the electromagnetic method has been used for difficult terrain ; the seismic method for depths more than 500 m ; and the low field NMR tomography technique developed by Soviet scientists and used as a test programme in India recently allows non-well water prospecting upto 100 m.

Let us consider the question of desalination. We have here quite a few years of activities in several agencies (CSIR, DAE, DRDO) and the involvement of public sector organisations like BHEL and desalination plants at demonstration level are currently available in a number of locations. But costs are still high and the membrane efficiencies need to be improved. There has already been some progress in this area with the use of improved cellulose acetate but the total package improvement needs to be taken up on a mission mode and indeed such a decision has been made recently.

The highly promising potential of the polymer Jalshakti is now clear, but needs to be evaluated in detailed quantitative way and costeffectiveness examined. The trails now currently being made in about 100 locations with the help of ICAR and others will form the base for such evaluation. Aerial seeding with Jalshakti-coated seeds has considerable promise.

The most important thrust should be on a long term estimate on the changing pattern of rainfall in the context of global warming. Estimated warming is between 3 to 5°C as a global average. Model predictions show an increase in overall precipitation between 7 to 11 per cent. The largest changes will occur between 30°N and 30°S. Over the Indian subcontinent more rain is predicted. There are two sets of empirical data giving indications of precipitation under such conditions : a very gross picture of the period 4000-8000 years ago when the world as a whole was warmer by about 3°C and an analysis of data for the last 50 years and choosing 1937, 1938, 1943, 1944 and 1953 as the five warmest years and 1964, 1965, 1966, 1968 and 1972 as the five coldest years. The difference was 0.6°C. For India there are important predictions in both these analyses. The first showed that much of India, especially the southern part, had large precipitation. The second showed that while there was decreased precipitation over the USA, most of Europe and Russia, there was increase in precipitation over India and Middle East. The increase in India varied from a few percent along the eastern coast (also in Bangladesh) to almost 100% in North-West. However, there was decrease in Southern India and in the North around Delhi.

Some Candidate Science Missions for future

It has often been mentioned that in regard to the societal missions there is a communication gap between academic communities and mission operation people primarily because the science or the technology component is either not clear or has not been properly worked out. On the other hand programmes like IGY or IMAP or SITE had tremendous support from the scientific and technological communities. One positive step would be to take up an increasingly large number of science based major programmes in mission mode.

A number of such programmes to be operated on mission mode have been suggested in various forums. Apart from the superconductivity programme which could develop in a mission mode programme, the Task Force set up by the Planning Commission has listed a wide variety of programmes ranging from fertility control ; environmentally acceptable pesticides, fertilizers and chemicals ; development and application of genetic engineering for bio-fertilizers to development and production of composites, hightech ceramics, superalloys ; production and application of lasers ; optical fibre technology ; solar photovoltaic power generation and applications ; energy conservation in core industries ; benefication of non-coking coals and slurry transportation ; exploration of economically viable ocean resources (fisheries, drugs, etc.). In addition, efforts have begun to design and build the Giant Metre Wave Radio Telescope (GMRT) ; Very Long Base line Interferometry for Geodesy and for Astronomy and development of new drugs of appropriate Indian interest. An apex body on superconductivity with the Prime Minister as Chairman is promoting and monitoring both basic and applied work in this area.

There is thus a fairly large number of candidate missions. This is not the right place to dwell upon such missions. Instead somewhat arbitrarily I will present before you three programmes which in my view offer exciting scientific potential. These are : (a) the International Geosphere-Biosphere Programme, (b) National Standards and Calibration Programme, and (c) Advanced Ceramics. The first has global implications, the second is the key to our technology up-gradation and the third is an area of emerging technology in which we have a reasonable chance of being competitive.

INTERNATIONAL GEOSPHERE-BIOSPHERE PROGRAMME :

Here is a programme that needs contributions from many agencies, institutions and universities not only in India, but globally, and will continue for years to come and will have to be taken up in mission mode.

This programme is yet to take off, but has been approved by the world scientific community as an interdisciplinary programme of the highest importance, perhaps the most ambitious and wide ranging and of the utmost urgency. The urgency comes from the recognition that the Earth and its atmosphere, its climate and the various components of the Earth System that sustain life have been changing since the beginning of the industrial age, because of human activities, but the changes have now become ominous. Examples are the warming of the global climate, sealevel rises, the Antarctic ozone hole, desertification, flood and soil depletion from indiscriminate and unplanned human activities. We have also recognized that there are limits to the habitability of the Earth, and its ability to support life. Human effects have already reached a scale that approximate that of the natural processes and are likely to overcome them soon.

To Indian scientists this programme is important in many ways. The global climatic changes affect all countries including India (although different regions are differently affected) and since our dependence on the monsoon system is more critical, one must understand the interaction of a gradually warming atmosphere with the factors controlling monsoon dynamics. Secondly, we have seen large depletions of ozone in the Antarctic and the beginning of a hole in the Arctic. If depletions spread elsewhere and the already thin ozone layer over the Indian subcontinent becomes thinner, a good part of India will be subjected to heavy doses of UV-B radiation. There are two effects of such large dosages ; skin cancer and effects on plant species. The latter may have serious consequences on the agricultural systems.

Thirdly, India is a major contributor to the global problem ; through biomass burning, slash and burn agricultural systems, existence of large paddy fields and cattle population. In 1982, biomass burning in India injected 190 million metric tons of C or 13% of all developing countries.

Over the years the upper boundary of the earth-atmosphere system has been successively pushed upwards to the far reaches of the earth-sun space to the end of the tail swept out by the solar wind: the earth in this context behaves just like a comet. We are thus concerned with physical and chemical features of a vast region several earth radii in extent, with variable boundaries with flow of energy and matter between different levels and between the sun and these levels. The principal target is the understanding of this linkage between the sun, the magnetosphere, the ionosphere, the middle atmosphere, the lower atmosphere. The sun with the radiation and particles it hurls into space is at the centre of this interaction. The solar constant has been found to change by about 0.1% and is correlated with appearance of sunspots. In the UV and X-rays changes occur with sunspot cycles and cataclysmically during solar flares.

Another important aspect is the changing climate. Evidences are mounting to show that concentrations of several greenhouse molecules are increasing: 1% per year for methane, 0.25% for N_2O, 4% for CFMs, 0.5% for CO_2. Over the decade 1975-85, CO_2 has increased by 4.6%, CH_4 by 11%, N_2O by 3.5%, F11 by 103%, F12 by 101%. The dispute is no longer on whether concentrations of these climatically important minor species are increasing, but on how much and on what effects consciously introduced constraints can bring about.

EL Nino-Monsoon connection has shown a mysterious angle. During the 1982 El Nino event both CO_2 and CH_4 showed sharp decreases ; after the event there was a sharp rise peaking early in 1984. This implies that 5×10^9 tons of fossil carbon burned during that interval were removed from atmospheric reservoir for temporary storage in the near surface ocean. The mechanism must be understood to proceed further.

A disturbing consequence of the warming is global sealevel rise. A global warming of 1.5 to 5.5°C is modelled to cause a sealevel rise between 20 and 165 cm with profound influence on habitation pattern. Such changes are already underway : sealevels are rising by 10 cm a century. A preliminary work by our scientists shows that for India a rise of this size would make the Lakshadweep Archipelago most vulnerable ; the east coast of India with its lower coastal slopes and higher cyclone frequencies will have increased storm surge damage ; the belt between 12°N and 18°N on the West coast will be least vulnerable but the region south of the belt will have increased coastal erosion.

There are implications on the entire agricultural system : not only due to changes in temperature and precipitation, but through high CO_2 concentrations and increased UV-radiation. A doubling of CO_2 concentration is likely to increase the growth and yield of C_3 plants by 10-50% (and of the world's 20 major crops, 16 are C_3 plants).

There are, therefore, many elements in IGBP that India will be interested in. Some will have to be taken on mission mode ; and there must be commitment in this programme for several decades. It is important to induct young people in a programme of such long term nature.

India is well equipped for the programme. Remote sensing technology is in an advanced stage. A network of 3 rocket ranges and the balloon facility is an advantage. Systems using unmanned data collection platforms and a central processing station through satellites have been introduced. The technology for collecting, processing, archiving, accessing and exchanging data is however, rather primitive in India. There is opportunity for involving university scientists in a big way.

IGBP is being planned by a Special Committee appointed by ICSU and its Secretariat is located in Stockholm. An Indian National Committee has been formed and possible elements of the Indian programme are beginning to emerge.

Four underlying themes constituting the scientific basis of IGBP have been specified. These are :

1 Documenting and predicting global change.
2 Observing and improving our understanding of dominant forcing functions.
3 Improving our understanding of interactive phenomena in the total earth system.
4 Assessing the effects of global change that will cause large scale and important modifications in the availability of renewable and non-renewable resources.

NATIONAL STANDARDS AND CALIBRATION PROGRAMME :

Although quality assurance of products is universally recognised as a crucial element in industrial development and a mission-mode programme "National Coordination of Testing and Calibration Facilities" (NCTCF) has been on the cards for several years, there is a multiplicity of organisations concerned with such a programme under different umbrellas and the progress has been slow. We have currently the Bureau of Indian Standards (BIS) laying down specifications of the goods produced, the National Physical Laboratory concerned with the realization and maintenance of national standards for physical measurements, the Directorate of Weights and Measures for legal metrological aspects, BARC in relation to ionizing radiations and the national measurement system under the title NCTCF under the umbrella of DST. Thus maintenance of primary standards is in one place. the legal enforcement is in another place, specifications are in a third place and the linkage between the various echelons is in a fourth place. Coupled with these is the question of standard reference materials so widely different for different types of products : little has been done so far on this aspect.

The NCTCF programme was very imaginatively drawn and the primary standards work in NPL is recognised to be of high quality. The starting point in the mission could be NCTCF so that testing and calibration down the line to consumer level is assured through the 3-echelon tier. One would have to consider also whether a single umbrella for all aspects of metrology including documentary and legal metrology should not be seriously considered.

A key element is the question of instrument development in which we are particularly weak. One should ensure indigenous production of at least Echelon 3 level instruments if we are to be reasonably self-reliant in the programme.

A satisfying feature has been the operation of the Asia-Pacific Metrology Programme for the last few years in which India has taken a major role. Some 18 countries have been collaborating in intercalibration activities as well as in training programmes. We can make use of this experience in linking this regional inter-comparison effort with wider international ones. In this context, it is important to note that the Commonwealth Science Council has recently assigned a Commonwealth-India Metrology Programme to Delhi which can form the nodal agency for such international linkage.

This scientific excitement will continue to centre around programmes relating to units of physical measurements to universal constants. Scientists with strong physics background can and should be attracted to these frontier-level activities.

ADVANCED MATERIALS :

Materials probably from the most important parameter in the technological development of a country, and advanced materials of various types are hotly pursued all over the world. Recognising its importance, the Scientific Advisory Council to the Prime Minister has issued a document called "Advanced Materials : National Priorities" in August, 1988. In this very extensive document, the status of selected advanced materials in the world as well as in India is described in some detail. The materials covered in this study include : non-load bearing materials, electronics materials, magnetic materials, oxidic and other single crystalline materials, load-bearing materials, metals and alloys, ceramics, polymers and composites.

We believe that it is time that one or two technology missions are undertaken in the area of materials. It is possible to consider seriously a number of candidate missions in the context of the expertise available in the country. I would like to restrict myself here to one in which there was a national debate under the auspices of CSIR very recently. This concerns the area of advanced ceramics : a class of ceramics produced synthetically from chemically prepared raw materials for specialised applications due to their special electrical, electronic, magnetic, optical or mechanical properties. There are two broad types : electronic ceramics and structural ceramics. These ceramics are bringing in a virtual revolution in technologies adopted for industrial sectors like electronics, power generation, transmission and storage, automobiles and machine tools. One of the earliest examples was use of spinel ferrites based on iron oxide for use as magnetic material at very high frequencies in the fifties. Since then a variety of synthetic advanced ceramics like titanates, alumina, zinc oxide, $LaCrO_3$, Si_3N_4 and zirconia have been developed. The international market for advanced ceramics was of the order of 5 billion US dollars in 1985 and is expected to go to about 50 billion US dollars by 2000 AD. The main product lines for future will be multilayer capacitors, ceramic engine components and integrated optical devices. Packages, capacitors and ferrites dominate the market now but the group felt that structural ceramics like cutting tools and autamobile parts will dominate the market over the next decade.

In India work on advanced ceramics started in the sixties and was centered around electronic ceramics. The first successful R & D effort was the ferrite—developed by several laboratories and taken up by a few industries in the sixties and seventies. The main thrust was in soft ferrites for radio, TV and communication industries and hard ferrites for scooters and loudspeakers. However, in the eighties, this R & D effort has been reduced. No laboratory-industry interaction exists today In the area of magnetic recording although R & D work on preparation of gamma-ferric oxide was carried out production of these materials was not taken up by the industry. The development in ceramic capacitors was similar to that of ferrites. In the eighties a large number of companies have been set up to produce disc type ceramic capacitors. R & D work on piezo-electric materials is being done in several laboratories and some piezo-electric transducers are being made with indigenous knowhow for small power and high power transducers. Work on alumina, zinc oxide, beta alumina, $LaCrO_3$ etc. has been on a very low key. The very imaginative CSIR-BARC programme on sodium-sulphur batteries with β-alumina tubes developed in NPL and elsewhere is worth pursuing.

Work on structural ceramics is limited. The Central Glass and Ceramics Research Institute has been working on silicon nitride ceramics for the last decade and has successfully produced some automobile parts. DMRL has been active on a variety of ceramics like oxides, carbides, borides and nitrides mainly for structural applications in Defence areas. No production facility exists and there are major gaps.

The group believes that the main growth areas in electronic ceramics in India will be in ferrites, magnetic tapes and ceramic capacitors: these alone will constitute products worth about Rs. 200 crore. While for ferrites and magnetic tapes the strategy could be essentially expansion in growth in volume by the industries with the help of their in-house R & D centres, in the case of ceramic capacitors one would need to create new production facilities for multilayer capacitors. Another product that seems promising is high pressure sodium vapour lamps which use transluscent tubes. The estimated market for 2000 AD is about Rs. 40 crore.

While a future market trend for electronic ceramics is not so difficult to predict, the situation for structural ceramics is not so clear. Development in this area has been driven essentially by the need for a ceramic engine. For India this need is not clear. Zirconia ceramics have strength and toughness values near those of steel at room temperature and can be used in a variety of other applications like cutting tools, scissors, etc. Some scooter and engine parts can also be attempted using zirconia ceramics.

Concluding Remarks

I have given you a list of a few past missions that succeeded, a few on-going missions where success is yet to be achieved and a few candidate future missions with global or national perspective.

From what I have said before, it is clear that the principal mission imperatives are: (a) involvement and commitment, (b) mission leadership entrusted to scientists and technologists, (c) ensuring that emphasis on management does not detract technological content, (d) redundancies in the system to be minimal, (e) milestones and evaluation strategies clearly specified. No mission works without involvement of all sectors of participants. Management is effective only if there is good deal to manage.

One needs also to ensure that young scientists and technologists are called upon increasingly to head such missions. Much of the success of the Antarctic campaigns is due to leadership of the young and the participants being young. The present group which has landed in the Antarctica only a few days ago is led by a young scientist.

There is a final element that we have not properly considered: the manpower question. At every stage of our mission progress, we are finding dearth of competent people. We can proceed on a double-pronged strategy: (a) increase R & D expert manpower two-fold in five to ten years and (b) provide pathways for using over 90% of S & T manpower which are not currently available for such activities. The hundred odd field centres of CSIR and the extension centres of ICAR can be and should be used for this purpose. The concept of "deemed university" status for some selected national laboratories can provide competent talent of the kind we are looking for.

I will end this lecture by quoting from Vikram Sarabhai who defended India's entry into space activities declaring,

> "There are those who preach as guardians of the economic well-being of the developing nations that they must proceed step-by-step following the same process by which the nations themselves progressed. One is often told that such and such a thing is too sophisticated to be applied. This approach disregards what should perhaps be obvious, that when a problem is great, one requires the most effective means available to deal with it".

This stems from a belief that to bridge a century's technological gap is not to follow others rung by rung, but pursue one's own efforts in the frontiers of knowledge. We have before us a whole new world ; we have to make the choice of what our role in this world is going to be. □

THE NATIONAL PLANNING COMMITTEE AND SCIENCE*

JAGDISH N. SINHA**

THIS paper seeks to study the nature, scope and significance of the endeavours of the National Planning Committee (hereafter NPC) towards promoting science and technology (S & T) and exploiting them for all-round progress of India. With the freedom struggle growing stronger and the prospect of country's liberation in sight, the NPC was constituted by the Indian National Congress in 1938. Its purpose was to prepare a comprehensive integrated plan on the basis of which the national government of free India would work to achieve an all-round development of the country. For this, the major areas of national activities and the state of natural resources of the land were studied, and recommendations were made for future progress.

Keeping in view the background of the foreign rule in India, the NPC was a historic collaboration, especially amongst country's political leadership; the scientists and industrialists, forged with the purpose of finding ways and means of getting the country out of the backwardness and stagnation caused by the long colonial rule. Such a move was a challenge to the political authority of the Raj, for, as an indigenous initiative, it was bound to affect the colonial interests adversely. It was a bold expression of the will of a subject nation to come out of the colonial rut and shape its own destiny. Above all, it was an expression of India's whole-hearted response to modern science and technology—a fact seldom accepted by the British and often overlooked by the people of the West at large. This response and the recommendations of the NPC had, no doubt, wide and long-acting implications for the future progress of science and technology in India.

Unfortunately, no proper study of the work of the NPC, particularly in respect of promoting and harnessing science, has been made so far. Its significance in this regard has been blurred by the hectic succession of events during the 1930s and 40s in India, such as the outbreak of the Second World War, political turmoils of the 40s and partition of the country. This inquiry is an effort to fill in this gap.

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*Presented at the Indo-Australian Seminar on Science, Technology & Colonialism : India and Australia held on 9-11 May, 1988.

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Background

The task undertaken by the NPC was the culmination of a long-drawn effort by Indians to use science and modern technology for the material progress of the country. Its origins may be traced to the Swadeshi[1] and the National Education[2] movements. When these movements lost strength, the indigenous concern for science was kept alive by the Indian National Congress.[3] In the meanwhile the First World War broke out in 1914. The contingencies of the War compelled the British Indian Government to look into the industrial question seriously, and the Indian Industrial Commission was appointed in 1916.[4] It offered Indians an opportunity to present their grievances and demands before the government.[5] A prominent Congress leader and a member of the Commission, Pandit Madan Mohan Malaviya, put forward his views on industrial and allied questions in an elaborate 'Note' of dissent, appended to the main Report.[6] In it, he expressed his fundamental disagreement with many traditional prejudices of the British about India's potentialities for progress on scientific lines, and called for radical changes in the official attitude.[7] Broadly speaking Malaviya's views represented the national opinion on the subject.

Unfortunately, the recommendations of the Commission were never put into practice; and Malaviya's views could never gain precedence on the Congress agenda. Actually, with the emergence of Gandhi on the national scene, modern industry, science and modern technology receded into the background for some years to come.[8]

During this peiod, however, some new forces of change were gaining ground. After the First World War, most of the countries were faced with an economic crisis. To meet with the situation, several countries resorted to various measures including national planning. It was only in Russia that the new socialist government tackled the situation without much difficulty. All this influenced the developments in India.[9] Here, a section of the national leadership—political as well as scientific—was attracted by the Soviet experiment. For them, now India's material salvation lay in socialism, heavy industrialisation, and science and technology.[10] The need for planning, too, was felt.[11] Meanwhile, Congress ministries were formed in most of the provinces after the elections of 1937. This placed the Congress in a new role. The need for economic recovery and a full-fledged national reconstruction was felt urgently. For this, the Congress appointed in October 1938 the National Planning Committee, with Jawaharlal Nehru as Chairman and besides others, several of the top Indian scientists and industrialists as members or chairmen of its sub-committees.[12]

The main aim of the NPC was to draw up a comprehensive plan for the industrialisation of the country. But in the process, it addressed itself to several associated subjects and offered its ideas on them.

With its 29 sub committees, the NPC started its work in the end of 1938. But the Second World War broke out the next year and the working of the Committee was disrupted. Anyhow it managed to hold its meetings till 1940, after which its work had to be suspended until 1945, on account of the political upheavals in the country. In 1945 it resumed its work once again, and the publication of its reports started the following year. The reports of the NPC and its various sub-committees embody the views of the national body, among others, on science and technology.

Application of S & T

As mentioned earlier, the main purpose of the NPC was to prepare a comprehensive plan for the industrialisation of the country. The scheme of planning envisaged provision 'for the development of heavy key industries, medium scale industries and cottage industries, keeping in view our national requirements, the resources of the country as also the peculiar circumstances prevailing in the country'.[13] Such industrialisation was assential for solving the problems of poverty and unemployment, of national defence and of economic regeneration in general.[14] It was in this context that the NPC realised the potentialities and immediate significance of science and technology. It, therefore, fervently advocated full application of S & T and recommended R & D in almost every sphere.[15]

The principal areas wherein the NPC wanted to make use of S & T were industries,[16] agriculture and the allied sectors,[17] population control and health,[18] and transport and communication.[19]

The various sub-committees probed into the condition in fields mentioned above; decided the direction of developmental effort; suggested the ways and means, and gave their opinion regarding choice of technology. As regards the process of planning itself, it involved a lot of basic scientific methods like collection of data and systematic survey.

Influenced by the ideas of socialism, most of the sub-committees and the parent body advocated wider state control and called for an over-all planning by the state. This meant also controlling, besides industries and agriculture, scientific education and research. But beyond suggestion, nothing concrete was done in this regard. As the call for heavy industrialisation was not exactly a voice of the majority within the Congress; the choice of socialism was not a favourit of all in the NPC. After all several sub-committees were manned by some of the leading industrialists of the time, some of whom had once openly come out against the Congress sympathy for socialism.[20] By now, however, the Congress and the Indian business class had come closer. In such circumstances the Congress along with the NPC did not mind encouraging private ventures by some Indian industrialists.[21] Also, steps were taken to start some large scale industries of national importance, particularly in the fields of machine and tools, chemicals, transport and communication, and power generation, but without much success.[22]

NPC's ideas and schemes were realised to an extent through indirect channels as well. The scientist members of the NPC carried its schemes to their own professional forums, while some of them, like M. N. Saha and S. S. Bhatnagar (later on the first Director-General of CSIR), did influence the official decisions by virtue of their being on the government bodies.[23] What is surprising, however, is the fact that neither the NPC nor Congress seems to have sponsored or encouraged any venture connected with agriculture about this time. This was contrary to the Congress concern for agriculture. This can be explained to some extent by the fact that at the highest level the party had come closer to the industrialists and there was hardly anyone on the NPC or the Congress really espousing the cause of the farmer.

Science Education and Research

The NPC found the most potent tool of industrialisation in science and technology, and visualised the prospect of their being applied in other spheres, too. But there were hurdles in the way. The existing state of scientific education and research was extremely poor. There was serious scarcity of technical know-how and technical personnel. To make things worse, there was also the lack of data on educational matters and research. The national Committee, therefore, paid special attention to the subject.

Two exclusive sub-committees—one on General Education, under Radhakrishnan as Chairman, and the other on Technical Education and Development Research, under M. N. Saha, considered the question of education and research. Many of the other sub-committees also took up the issue of science education and research, including R & D, in relation to the field of their inquiry like industry, agriculture and health.

The two sub-committees on education were of the opinion that there should be adequate provision for scientific and technical education and research.[24] A limited type of technical education was favoured at the secondary school level, and advanced scientific and technical education and research was advised at the university and similar levels[25] The two committees, however, differed on the concept of Basic education, and the sub-committee on technical education opposed vocationalisation of education at the early stage in the school.[26] As to the technical education, it suggested for the establishment of polytechnics, provision of apprenticeship, 'Refresher' Courses and 'Continuation schools'.[27] Interestingly, it favoured the introduction of 'cultural subjects' (humanities) in engineering and technical education.[28]

Considering India's special problems of backwardness, effective introduction of compulsory primary education, and of the mother tongue as a medium of instruction were considered necessary for any progress in scientific education and research.[29]

Apart from the sub-committees on education,[30] researches of applied nature, and technical training for specific purposes were widely recommended by the various sub-committees, and a close relation between the laboratory and training centres, and industries as well as the departments concerned was stressed upon. This implied an emphasis on R & D also.[31]

The sub-committee on technical education suggested that 'Every educational institution of the university standard...... should be equipped with men, machines and instruments, for carrying advanced research work'.[32]

A close examination of the proceedings and recommendations would, however, reveal a few serious shortcomings. First, for example, the NPC did not pay attention towards reviving and encouraging India's traditional sciences like *Ayyurveda* and *Unani* systems. Its attitude in regard to those crafts which promised utility was hardly better. Secondly, even though concern was shown for fundamental research, no details were spelt out as to how to encourage it.

Management of Science

The NPC and its sub-committees did discuss fairly in detail the question of management and control in several areas with implications for the government of science. From this point of view it touched upon such aspects as administrative control, organisation, cooperation and coordination in research and training, resources and finance, and supply and employment of scientific personnel. The sectors likely to fall under state control and those suitable for private initiative were demarkated. While the state was entrusted the over-all responsibility for scientific education and research in general, participation of private endeavour was allowed at the different levels in this regard. But this was permitted only in case the state was unable to share the responsibility due to resource constraints.[33] The sub-committee on general education opined :

"The provision of the highest degree of Technical education, and the organisation of Scientific Research, must necessarily be an integral part of the Educational sector in the National Plan. The obligation in that behalf must primarily be that of the State. At the earliest stage... this obligation may be placed on the employers, i.e. factory management and workshop direction in every item of the Plan. But the basic obligation must be of the State, carried out as an integral part of the plan by whatever agency the State deems appropriate for the purposes in the several stages.

At the highest stage, this obligation may be discharged by some semi-autonomous statutory body like a Federal or Union University, or special institutions, such as those now existing at Bangalore, Ranchi, or Dehra Dun. But in every case a measure of State control and supervision must be ensured primarily to see that these bodies and institutions function in conformity with the main Plan, and the researches carried out are mutually coordinated so as to make a consistent programme."[34]

It further remarked : "The need, therefore, of reorganising and reconditioning University Education with special reference to Technological and Scientific Research as integral part of the Overall National Plan, becomes incontestible".[35]

The mutual and internal cooperation and coordination amongst the different bodies dealing with scientific education and research, and those making use of them, such as academics, laboratories, government departments and industries, etc., were constantly emphasised by both the committees on education and those relating to industries and the like. This was required for maintaining a balance between the demand and supply of scientific personnel.

For the purpose of scientific education and research, the necessity of vastly increased financial resources was felt by most of the subcommittees, and ways and means to raise them were suggested. The responsibility of the State in this regard was placed at the highest.[36]

An Assessment

After examining the reports of the NPC, one may like to ask : Did the NPC really yield some significant results ? How did the colonial government react to it ? What were its shortcomings ? And, finally, what were its contributions, especially for a country that would soon emerge as a free nation ?

To begin with, it is important to note that the aim of the NPC was to formulate a plan for national reconstruction, and not to implement it. In fact, it was to be implemented by a national government of independent India that was yet to come into being. Thus, there is no question of expecting any results in material terms. But as to its original purpose, despite the many constraints, it made detailed inquiries into the different sectors of the national life and produced a series of valuable reports.

By its constitution, it had brought together the top leaders not only in politics but also in science, industry, economics and other areas ; by its deliberations and by publishing its reports, it provided a common programme to fight for. The deliberations and, subsequently, its reports exposed the extent and nature of the country's backwardness, the responsibility of the foreign rule for it, and, hence the necessity of freedom from the foreign rule. The political leaders on the Committee realised the value of scientific and technological independence for political salvation ; and scientists, in their turn, understood the significance of political freedom for the advancement of science. This explains the political overtones of contemporary scientists and concern of the political leaders for science in those days.[37] This situation was created in an indirect manner. The cause of the NPC was soon taken up outside the Committee by some of its scientists members. The proceedings of the NPC and views of its members on scientific matters were published in the prestigeous journal, the *Science & Culture*. The *Science & Culture* group led by Saha helped in forming a national opinion on scientific matters on the same lines the NPC followed. Growingly it was realised that science could not progress in isolation—cut of from socio-economic and political realities.

The views held by the NPC and propagated, among others, by the *Science & Culture* largely represented the national aspirations, and thus bound to militate against the imperial interests. The NPC had exposed the weaknesses of the science policy of the Raj ; its understanding and suggestions showed how science could be used for national reconstruction. This is why the British Indian Government did not cooperate with the Committee and generally remained hostile to it.[38] This put great limitations on the efforts of the Committee and made its task difficult.

This apart, the Committee had its own shortcomings, too. For example, being overwhelmingly biased in favour of industrialisation, the Committee did not pay as much attention to agriculture as it did about industry. In fact, in the beginning no exclusive sub-committee had been formed to deal with agriculture. We have already tried to explain in the preceding pages why it was so. Likewise, the views and recommendations of the Committee were beset with certain inherent contradictions : While progressive elements on the Committee were all for modern science and socialism, the conservative members quite often opposed radical measures. For example, while the members of the sub-committee on population resolved to adopt an "eugenic programme", including the sterilization of persons suffering from transmissible diseases of a serious nature, such as insanity or epilepsy, some of its members were opposed virtually to the idea of birth control itself[39] A section of the National Committee, no doubt, wanted to introduce wide state control but private enterprise was not ruled out. Such divisions of opinion deprived the plan of its thrust and sapped the political will necessary for its implementation.

However, despite these weaknesses, the Committee made some valuable contributions in its own way. Besides underlining the areas and nature of backwardness, it provided a detailed scheme for future development with prime emphasis on science and technology, and thus laid the basic foundations of India's national science policy. ☐

Notes and References

[1] For Swadeshi, see *The Swadeshi Movement—A Symposium*, (G. A. Natesan & Co., Madras, N.D.) ; and Sumit Sarkar, *The Swadeshi Movement in Bengal*, (PPH, New Delhi, 1973).

[2] See the *Dawn*, the journal of the Dawn Society ; Haridas Mukherjee and Uma Mukherjee, *A Phase of the Swadeshi Movement (National Education, 1905-1910)*, (Chakerverty, Chatterjee & Co., Calcutta, 1953) ; and their famous work, *The Origins of the National Education Movement (1905-1910)*, (Jadavpur University, Calcutta, 1957) ; also Sumit Sarkar, op.cit., especially chapter IV.

[3] For the Congress attitude towards science, see Jagadish N. Sinha, "Science and the Indian National Congress : A Study in Indigenous Response to Science under Colonial Rule" (a paper presented at an international seminar on "Science and Empire", organised by NISTADS (CSIR) in 1985 in New Delhi).

[4] *Indian Industrial Commission 1916-18—Report* (Govt. of India, Calcutta, 1918), in seven volumes.

[5] Ibid. See particularly appendices and the minutes of the evidence.

[6] "Note by the Hon'ble Pandit Madan Mohan Malaviya", in the *Indian Industrial Commission 1916-18—Report*, pp. 292-355.

[7] Ibid.

[8] For Gandhi's views on science and technology, see M. K. Gandhi, *Hind Swaraj or Indian Home Rule* (Navajivan publishing House, Ahmadabad, 1911; reprinted 1938); and idem, *Modern v. Ancient Civilization*, edited by Anand T. Hingorani (Bharatiya Vidya Bhavan, Bombay, 1970), especially pp. 22-27, 47-48, 55-56, 71, 73-76, 98-99, 109-10. Also see the Congress resolutions at the annual sessions No. I, 1921; XI, 1923-24; II, 1924.

[9] See, for example, "National Planning in Sweden", editorial in *Science and Culture*, Vol. IV, No. 12, June 1939, pp. 669-73; "Planning and Prospect", editorial in *Science and Culture*, May 1944, pp. 457-62; Sir M. Visvesvarayya, *Planned Economy for India*, (Bangalore Press, Bangalore; second edn. 1936); and the much famous Bombay Plan, in Sir Purshotamdas Thakurdas *et al*, *A Brief Memorandum Outlining a Plan of Economic Development for India* (Bombay, 1944).

[10] For the views of political leaders, see Nehru's presidential address at the annual Congress session in 1936; his message on the occasion of the silver jubilee of the Indian Science Congress, in *Selected Works of Jawaharlal Nehru*, Vol. VIII (Orient Longman, New Delhi, 1976), pp. 806-8; "The Congress President on National Reconstruction", editorial in *Science and Culture*, September 1938; in the same Volume, "Address of the Congress President—Mr Subhas Chandra Bose", pp. 139-41; see also Nehru's *Glimpses of World History*, (1934-35; New edn. Jawaharlal Nehru Memorial Fund, New Delhi, 1982), pp. 638-75. For the views of Indian scientists, refer to "Indian National Reconstruction and the Soviet Example", editorial in *Science & Culture*, October 1937, pp. 185-8; "Problems of Industrial Development in India", editorial, ibid., May 1937, pp. 529-31, 577; ibid., "Industrial India", editorial, January 1939; Presidential Address by J. C. Ghosh at the Indian Science Congress, 1939.

[11] Refer to footnote no. 9.

[12] See *Report : National Planning Committee*, (Vora & Co. Publishers, Bombay, 1949), pp. 9-10 (All the NPC reports were edited by K. T. Shah and published by Vora & Co. from Bombay, hence no further reference to these details). Also see Jawaharlal Nehru, *The Discovery of India*, (1945; Reprint: Asia Publishing House, Bombay, 1964); pp. 418-27.

[13] *Report : National Planning Committee*, op.cit., pp. 5-6.

[14] Ibid.

[15] Ibid, pp. 5-19, 35-7, 44-64, 65-85. It is evident, besides the reports, from the proceedings and inqueries from and instructions to, the different authorities and agencies. For this, see AICC File No. G-23 (KW-1, 2 & 3) 1940, at Nehru Memorial Museum and Library, New Delhi.

[16] NPC Reports : *Mining and Metallurgy* (1948); *Chemical Industries* (1947); *Manufacturing Industries* (1947); *Engineering Industries and Scientific Instruments Industries* (1948); and *Power and Fuel* (1947).

[17] NPC Reports : *Crop Planning and Production* (1948); *Soil Conservation and Afforestation* (1948); *River Training and Irrigation* (1947); *Land Policy and Agriculture* (1948); and *Animal Husbandry, Dairying, Fisheries and Horticulture* (1948).

[18] NPC Reports : *Population* (1947), and *National Healh* (1948).

[19] NPC Reports : *Transport Services* (1949), and *Communications* (1948).

[20] Refer to the 'Bombay Manifesto". For a detailed discussion, see Rajat K. Ray, *Industrialisation in India—Growth and Conflict in the Private Corporate Sector 1914-47*, (Oxford, Delhi, second impression 1985), pp. 325-33.

[21] Such ventures had been launched by Walchand Hirachand and the Tatas. See the *Report : National Planning Committee*, op.cit. Also see "Report on the proposed Automobile Factory in Bombay" (1939), in Confidential AICC File No. G-23/1940 (KW-18, 19, 20, 21) (NMML, New Delhi).

[22] *Report : National Planning Committee*, op.cit., pp. 5-8.

[23] Among others, see the Proceedings of the Indian Science Congress, National Institute of Sciences of India, Indian Science News Association; and M. N. Saha and S. S. Bhatnagar Papers (at NMML, New Delhi and National Archives of India, respectively).

[24] NPC Reports : *General Education and Technical Education and Developmental Research* (1948), pp. 32-35, 39-43, 139-50.

[25] Ibid., pp. 32-43.

[26] Ibid, pp. 139-44.

[27] Ibid., pp. 146-55.

[28] Ibid., p. 149.

[29] Ibid., pp. 150-53.

[30] Ibid., pp. 40-43, 149-50.

[31] Refer to NPC Reports : *Manufacturing Industries*, op.cit., pp. 82-3 ; *Engineering Industries and Industries connected with Scientific Instruments*, op.cit., pp. 68-74 ; *Power and Fuel*, op.cit., pp. 45-51, 124-27 ; *National Health*, op.cit., pp. 35-36, 58-70, 138-39, 190-22, 224-26 ; *Communications*, op.cit., pp. 82-83, 91-93 ; *Mining and Metallurgy*, op.cit., pp. 39-41, 66-70, 102 ; *Soil Conservation and Afforestation*, op.cit., pp. 34-37, 188 ; *River Training and Irrigation*, op.cit., pp. 62, 86-88, 111-12 ; *Crop-Planning and Production*, op. cit., pp. 22-28, etc.

[32] *Education*, op cit, pp. 150, 156.

[33] Ibid., pp 32-34, 41-46.

[34] Ibid., p. 41.

[35] Ibid., pp. 37-44, 144-55 ; also see *Engineering Industries and Industries connected with Scientific Instruments*, op.cit., chapter XI ; *Mining and Metallurgy*, op.cit., pp. 39-41, 66-70 ; refer to other reports also.

[36] Among others, see *Education*, op.cit., pp. 46-48, 168-72.

[37] Refer to the views particularly of Nehru, M. N. Saha, J. C. Ghosh and many others who spoke on the subject with conviction and eloquence during this period. As a handy source, one may find the *Science and Culture* full of such references. See also proceedings of the Indian Science Congress, National Institute of Sciences of India and such other forums.

[38] The government records are generally silent about the NPC and its activities. But the non-official sources frequently speak of the non-cooperation by the government and its hostility.

[39] See Minutes of the NPC meeting, 9 May (afternoon) 1940, in AICC File No. G-23 (KW-1, 2 & 3)/1940, p. 32, at NMML, New Delhi).

Notes and news

Substitutes galore at science meet

The dominant feature of the proceedings of the 76th session of the Indian Science Congress has been the "no show" by key speakers slated in the final programme, particularly the plenary sessions on the focal theme "Science and technology in India : technology missions."

The organisational lapses and lack of commitment on the part of invited speakers had their most telling effect on the session on "Science for peace : environment and development" on January 9, when none of the four speakers listed in the final programme showed up. The scheduled speakers were Prof. C. N. R. Rao, Dr. T. N. Khoshoo, Prof. Rais Ahmed and Dr. B. Vohra. The session was a fiasco with impromptu substitute speakers.

Call for blacklisting : The situation prompted a foreign delegate to remark that the organisers should blacklist the "no show" people, however eminent they were. This session, in fact, had been expected to take place as planned as the speakers had not been changed from the provisional programme issued in November, to the final programme issued on January 7. It may be of interest to point out that the first two names were here on the day of inauguration by the Prime Minister.

The fact that session was to have been chaired by the late Vice-Chancellor of the Madurai Kamaraj University makes it even more distressing. Similar was the predicament of the sessions devoted to the focal theme itself, "Technology missions."

The Adviser to the Prime Minister on

Technology Missions, Dr. Satyen Gangaram Pitroda, who was to have been the first speaker of the science congress never showed up, on January 7, or later. His name was on the schedule in all the three versions of the programme : the provisional one, the pre-final one of January 6 and the final one. Dr. Pitroda was to give an overview of national technology missions.

Two other speakers in this opening session on "Science and technology scenario and technology missions," Dr. K. Kasturirangan of ISRO and Prof. Yash Pal, UGC Chairman and the general-president elect of the Indian Science Congress Association for 1989-90, were substituted at the last minute. Since somebody had to speak on missions, Dr. Ram K. Iyengar, Assistant Director-general, CSIR, was called upon to speak briefly on the CSIR's role in national missions. He had anyway been scheduled for today and he did deliver a longer lecture in the session.

Three substitutes : Today's session was on programmes of national agencies on technology missions. Apart from Dr. Iyengar, the other slated speakers were : Dr. L. K. Doraiswamy, Director, National Chemical Laboratory, Pune, Mr. C. S. Sastry, Secretary in the Ministry of Agriculture, to speak on the oilseed mission, Mr. Gauri Ghosh, Director of the Water Mission, and Dr. Vasant Gowariker, Secretary, Department of Science and Technology.

The last three had to be substituted in the final programme (Dr. Ramachandran and Dr. Gowariker were around for the first few days of the Congress) by Mr. R. V. Shenoi, Oil Seeds Mission Director, Mr. S. C. Jain, Immunisation Mission Director, and Mr. G. T. Narayan, Telecom Mission Director, respectively.

With the inclusion of Mr. Narayan one had hoped to hear about the Telecom Mission though discussion on this had not originally been planned for in the congress. But the last day's session which was intended to give the audience a comprehensive picture of the various missions, was a damp squib...

None of the replacement speakers showed up. Both Mr. Shenoi and Mr. Jain had deputed their subordinates and Mr. Narayan did not even bother to do that. As for the audience, there were only 25 to 30 to hear about the missions.

From the record of events, it can be said that Dr. A. P. Mitra, Director-General, CSIR, as the general president of the ISCA, ensured that the CSIR speakers did not become the cause of proceedings being marred and resulting in being aimless and missionless. ☐

The Hindu

'N-energy for peace'

The discovery of nuclear fission by Otto Hahn and Fritz Strassman in December, 1938 and the later work of Enrico Fermi on nuclear chain reaction have put the prospect of abundant nuclear energy in the hands of man and nations should harness it for peaceful purposes as Fermi envisaged, according to Prof. Virendra Singh, Chairman of the Board of Research in Nuclear Sciences, Department of Atomic Energy.

Prof. Virendra Singh, who is also the Director of Tata Institute of Fundamental Research, said that both Dr. Homi Bhabha, who ushered India into the nuclear age and Fermi passionately believed that atomic energy should be used for peaceful purposes.

Prof. Singh was inaugurating a special seminar on "Nuclear Fission" to commemorate the golden jubilee of the discovery of nuclear fission. The seminar formed part of the symposium on "Radiochemistry and Radiation Chemistry", organised at the Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam. (While the fission of uranium atoms by neutrons was discovered by Hahn and Strassman in December, 1938, it was officially reported on January 6, 1939).

The dropping of atomic bombs on Hiroshima and Nagasaki brought to the notice of the public the awesome destructive potential of nuclear energy. India was using nuclear energy for peaceful purposes and the projects cleared so far were so enormous that the country could reach the target of 10,000 MW of nuclear power by the turn of century, Prof. Singh said.

Unmatched advances : Dr. R. M. Iyer, Director of the Chemical Group, Bhabha Atomic Research Centre, Bombay, who presided, said it was appropriate to celebrate the golden jubilee of the discovery of nuclear fission at Kalpakkam as it was the site of three generations of nuclear fission reactors—pressurised heavy water reactors of Madras Atomic Power Station (fuelled by Uranium 235), the uranium-plutonium-carbide-fuelled Fast Breeder Test Reactor of the IGCAR and the latest Uranium 233-fuelled KAMINI reactor getting ready for operation. A range of such technological advances could, perhaps, be found nowhere else in the world.

Dr. D. D. Sood, President, Indian Association of Nuclear Chemists and Allied Scientists and also Head of the Department of Fuel Chemistry Division, BARC, Bombay, stressed the need to spread the message of nuclear science in the country. The Association was trying to popularise nuclear science through seminars, workshops, etc. □

The Hindu

Melatonin : acting like clockwork

Melatonin affects the ticking of the human biological clock. This hormone is rhythmically produced—in higher amounts at night than during the day—by the pineal gland of the brain. It has been found that in human brains, both those of adults and those of fetuses, binding sites for melatonin are concentrated in and restricted to the suprachiasmatic nucleus of the hypothalamus. This brain appears to be site of the human biological clock where each day, as the light-dark cycle proceeds, the body's circadian rhythm is synchronised to a 24-hr period. The suprachiasmatic nucleus has direct connections to the eyes and has, in a number of other mammals, also been shown to be the site of a biological clock. Clinical uses of melatonin have included the alleviation of symptoms of jet lag and the successful re-entrainment of the disturbed biological rhythm of a blind person. With improved understanding of its mode and site of action, the use of melatonin for adjusting biological rhythms in the blind, in shift workers and in travellers is likely to escalate. □

Science

Counting insects with light and sound

Taking a clue from bat sonar systems, an entomologist at US Agricultural Research Service in Weslaco, Texas, has developed a device, using sound to monitor flying insect populations in crop fields.

Dubbed "sodar," for sound detection and ranging, the system can alert farmers when insects are particularly active so that pesticides can be applied, says Don E. Hendricks. He adds that "accurate [insect] counts eliminate unnecessary pesticide use". The device, which counts insects with 92% accuracy, looks like a miniature rocket and utilises pheromones to attract insects into an echo receiver. Each echo causes one radio signal to be sent to a computer located some distance from the field. Another device designed by Hendricks uses pheromones and infra-red light to count insects. Both instruments detect moths of several major pest species, including tobacco budworm, corn earworm, cabbage looper, fall armyworm, southwestern corn borer and sugarcane borer. "These systems could pay for themselves in a year or two with the money saved in labour needed to count insects," Hendricks states. ☐

Bioscience

The benefits of buzzing

Some species of bee pollinate flowers by embracing their anthers, closing their wings and buzzing. This buzz discharges a cloud of pollen, some of which settles on the bee. Sally Corbet and colleagues, at Cambridge University, have confirmed that this method of collecting pollen occurs by design rather than as a result of a happy accident.

The researchers found that the bumble-bee (*Bombus terrestris*) emits a high-frequency buzz specifically to gather pollen from the kiwi fruit (*Actinidia deliciosa*) in New Zealand. The buzz, at between 300 and 400 hertz, is significantly higher than the usual buzz it emits while flying, which is 175-200 hertz. The kiwi fruit produces no nectar, the sole purpose of the bee's visit being to collect pollen.

Corbet found that bees only visited flowers when the pollen was dry and powdery. During a 24-hr study of Comfrey (*Symphytum officinale*), she found that bees visited the plant more often when the temperature was high or the vapour-pressure deficit, a measure of the drying power of air, was also high.

The kiwi fruit produces many anthers in a tufted arrangement, rather like a shaving brush, to assist buzz pollination. The researchers noted that the structure of another flower, the shooting star (*Dodecatheon meadia*), also enhances buzz pollination. The flower has a small number of stamens arranged in a cone protruding from the corolla. The lobes of the corolla are turned backwards to make it easier for the bee to enter.

Although many details of buzz pollination are still unknown, recent research seems to indicate that it is a widespread phenomenon. The independent evolution of the process in different plants and bees suggests that it is an efficient method not only of pollination but also collecting pollen. ☐

New Scientist

Long-life salamander

Biologists in the Soviet Union have resuscited an Asiatic salamander which had been frozen for 90 years. Researchers at the Magadan Institute of Northern Biology in the far east of the country revived the salamander by placing it in a tub of cold water.

Daniil Berman, head of the institute's biocenology laboratory, explained that the salamander usually lives for about 10 years. The animal has the biggest liver for its body size of all vertebrates—nearly one-third of its body weight.

When the temperature falls, glycogen stored in the liver is converted into glycerine and spreads throughout the body, where it acts as an "anti-freeze". This anti-freeze prevents the salamander's cells from crystallising. However, when the body cools down to −40°C, crystals of ice are just under the skin, but the tissues remain elastic.

No other animal can survive such low temperatures, although some North American species of frog can survive at −9°C. According to Barman, salamanders hibernate under tree stumps and hummocks of earth, and some will travel down several metres through cracks in the soil. If the cracks then become clogged with ice, the animal is stuck. Barman believes even older specimens may be found. ☐

New Scientists

Letters to the editor

Host range studies of tomato spotted wilt virus

Tomato spotted wilt virus (TSWV) was first reported in India on tomato[7]. Occurrence of TSWV on a legume[6] and on chilli[5] were also reported. The leaf curl disease of greengram and blackgram have recently been shown to be caused by TSWV[2,4] and field trials showed that TSWV can also cause[3] disease on pea broad bean, cowpea and soybean.

In August 1986 and 1987 at the Millets and Pulses Breeding Station, Tamil Nadu Agricultural University, Coimbatore, lablab, beans and soyabean showed the following symptoms :

On lablab the undersurface of leaves showed small specks of necrotic spots. Later the leaf lamina turned greenish red and streaks were observed on petiole and midribs. If infection is severe the plant starts drying. During Kharif 1986, 4.2 per cent of disease was recorded.

On French beans similar symptoms as seen in lablab were observed. If the plants are infected at early stages, they start drying. During kharif 1986, the incidence was 3.6 per cent.

On soyabean on the undersurface of the infected leaves bronzing was observed. Later it spreads to leaf lamina and also to midrib and petiole. In severe cases of infection, the plants collapse (Fig. 1). The disease was noticed to the extent of 3.8 per cent during kharif 1986 and 4.7 per cent during 1987 kharif.

The infected leaves from all the three hosts were tested for its infection. Sap transmission was made, using ice tray technique and by grinding young infected leaves with cold 0.1 M phosphate buffer (pH 7.0) and inoculated on the indicator plant viz. cowpea C 152 (*Vigna unguiculata* (L.) Walp) which was previously dusted with carborundum powder (600 mesh). Excess inoculum was washed with water. The inoculated leaves developed chlorotic lesions 4 days after inoculation.

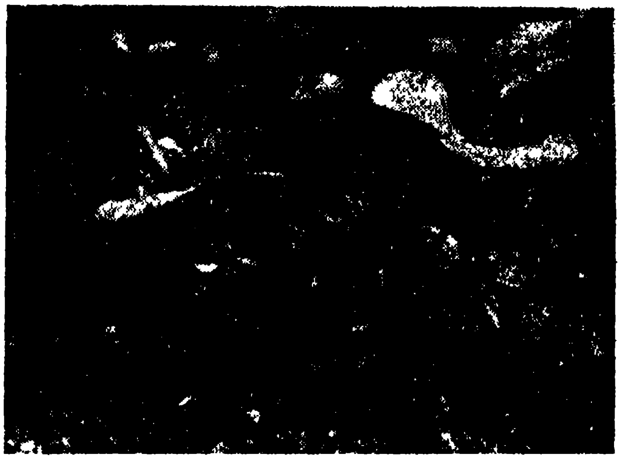

Fig. 1. TSWV infected soybean plant

The chlorotic spots from cowpea was back inoculated to soyabean, mochai and lablab. Typical symptoms as observed in field developed upon artificial transmission after 7-10 days. Symptoms developed on the respective hosts such as bronzing and severe necrosis were similar to those of TSWV infection on tomato.[1] The virus produced necrosis on many plants tested and quite unstable in crude sap. TSWV caused bud necrosis of groundnut[2]. The production of local lesions on cowpea C 152 cultivar was also reported earlier.[8] Based on the above said characters, the virus was identified as Tomato Spotted wilt virus.

Thirty entries were screened under field conditions for the occurrence of TSWV. Three entries, viz., UGM 21, 24 and 25 were free from the TSWV infection. The disease incidence in different cultures ranged from 0 8 to 4.8% and the vector thrips (*Scirtothrips dorsalis*) population was 1.0 to 13.1 during 1987 kharif season. However, in seasons of high-vector population, the virus poses a potential threat to this crop.

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Histological changes and mortality in *Abutilon indicum* seedlings induced by phenoxy herbicides

Interest in herbicidal activity and physiological similarity of phenoxy compounds with natural growth regulators envisages that a study of histological responses of plants to herbicides may reveal their mode of action.[1] The effect of herbicides on the structure and function of conducting tissue is of great importance, because the life of a plant depends on the normal activity of the vascular system[2]. Keeping this object in view, the present communication deals with the histological responses of *Abutilon indicum* (L.) Sw. to five phenoxy herbicides. *A. indicum*, a hairy perennial undershrub, is abundant in hotter parts of India[3] and is generally common along roadsides and in high cultivated lands.

Healthy seeds of *A. indicum* were acid-scarified (conc. H_2SO_4 for 24 hr), washed thoroughly in water and sown in potted soil. After a sufficient number of seedlings emerged, they were thinned down to 10 per pot. When the seedlings were 30-day old, they were aerially sprayed by means of hand-held pressurised sprayer with five different herbicides : MCPA (4-chloro-2-methylphenoxy-acetic acid), 2, 4-D (2,4-dichlorophenoxyacetic acid), 2,4, 5-T (2,4,5-trichlorophenoxyacetic acid) and 2, 4, 5-TP [2.(2, 4, 5-trichlorophenoxy)-propionic acid] and 2, 4-DB [4-(2, 4-dichlorophenoxy)-butyric acid]. Aqueous solutions of these herbicides were made to give 10, 100 and 500 ppm of the active ingredient. The pH of the solutions were adjusted to 7.0. For aerial application, 250 ml of each concentration was sprayed to the dripping point on the aboveground portion of plants in each pot. There were 8 pots per treatment, each pot containing 10 seedlings. From such replicates, percentage mortality of seedlings was registered and adequate samples were available for histological study. Hand-sections of stems were made before and after the application of herbicides to trace the histological changes. These sections were stained with Saffranin-light green and studied under the microscope. Measurements of various tissue zones were taken with the help

TABLE 1 : Anatomical changes in *A. indicum* stems as affected by aerial spray of one-month old plants with herbicides

Herbicide concentration (ppm)		Percentage of increase in diameter of the internode	Thickness of cortex (as percent of stem radius)	Thickness of tissue between xylem and cortex (as percent of stem radius)	Diameter of cortical cells (mm)	Diameter of pith cells (mm)	No. of proliferations
Water Control		6.7	21.4	11.5	0.05	0.07	0
MCPA	10	53 4	12.2	41.4	0 08	0.10	0
	100	108.8	10.2	62.4	0.10	0.10	18
	500	88.1	9.0	48.5	0.10	0.11	28
2, 4-D	10	78.7	9.5	47.3	0.08	0.08	17
	100	125.5	8.9	57.0	0.10	0.10	22
	500	75.1	9.7	33.1	0.10	0.10	29
2, 4. 5-T	10	43 3	13.7	25.5	0.06	0.07	12
	100	110.8	9.8	54.8	0.09	0.10	15
	500	39.4	11.0	48.2	0.10	0.09	30
2,4,5-TP	10	39.0	11.5	20 7	0.09	0.09	12
	100	86.1	12.2	53.6	0.09	0.09	12
	500	78.8	7.0	51.1	0.08	0.09	23
2, 4-DB	10	59.2	13.3	35.4	0.09	0.09	15
	100	70.7	11.5	41.3	0.08	0.10	24
	500	77.4	10.1	37.4	0 08	0.11	28

of a standardised ocular. There was an average of 20 readings for each parameter given under Table 1.

With 100-500 ppm MCPA, 2, 4-D and 2, 4-DB, all plants were killed (Fig. 1). But 2, 4, 5-T and 2, 4, 5-TP were lethal at 500 ppm only. Histological changes, alongside vital derangements, hastened death at lethal concentrations while treated stems retained architectural changes at sublethal doses. With the spray of phenoxy herbicides cambium, endodermis, pericycle, phloem parenchyma, medullary rays, etc. undergo active cell division (Fig. 2). The diameter of treated internodes increased tremendously (Table 1). Such increases were conspicuous at 100 ppm of MCPA, 2, 4-D and 2, 4, 5-T. Compared to the control, stem cortex was not thickened by herbicidal treatments. But the tissue between cortex and xylem was greatly expanded, being maximum at 100 ppm of all herbicides tried. Herbicidal sprays did not enhance the diameter of cortical and pith cells, the relative value being not much higher than the control cells. While proliferations were evident with almost all treatments, they varied from the production of numerous primordia (2, 4, 5-T and 2, 4, 5-TP) to extreme fasciation where cell-masses lost their structural and functional activity (MCPA, 2, 4-D and 2, 4-DB).

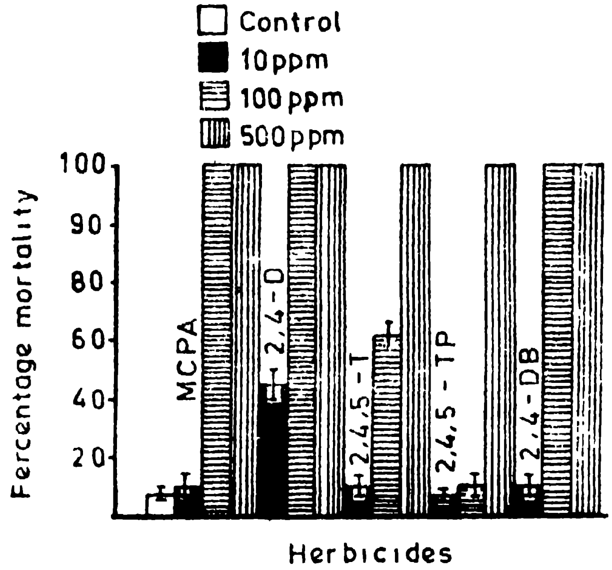

Fig. 1. Percentage mortality of *A. indicum* seedlings as affected by various concentrations of five phenoxy herbicides.

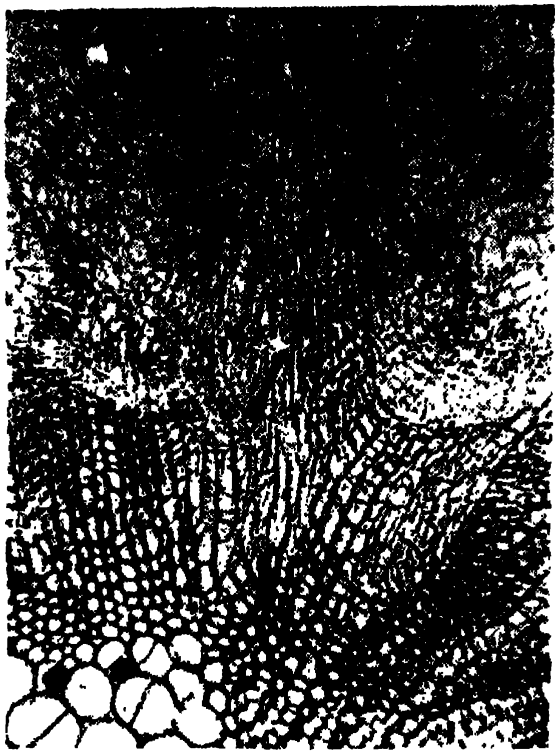

Fig. 2. Proliferative growth, extending from cambium to cortex, as induced by 500 ppm 2, 4, 5-TP.

The five herbicides tested were similar in action, confirming previous reports on other plants[4-10]. The cells of cortex and pith enlarged probably due to the increase in turgidity. Moreover, cortical cells degenerated due to the centrifugal force exerted by meristematic activity in the vascular system. In this connection, 2, 4-D, MCPA and 2, 4-DB were more effective than 2, 4, 5-T and 2, 4, 5-TP. The proliferations in the stem were composed of root-forming tissues with the use of higher dose of the last two compounds. These raw materials were extremely disorganised and hardly recognisable as functional elements of the root with other phenoxys.

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Received: 12 May, 1988.

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On the morphological abnormality in a minor carp, *Puntius filamentosus* (Val.)

Puntius filamentosus is a very common fish in the rivers of South India. In Aliyar reservoir (Tamilnadu), it forms a minor fishery and seems to compete with the economic fishes Therefore, a detailed study was undertaken to elucidate its biology. In the course of this investigation, an abnormal specimen was recorded from the departmental gill net catches (Fig. 1).

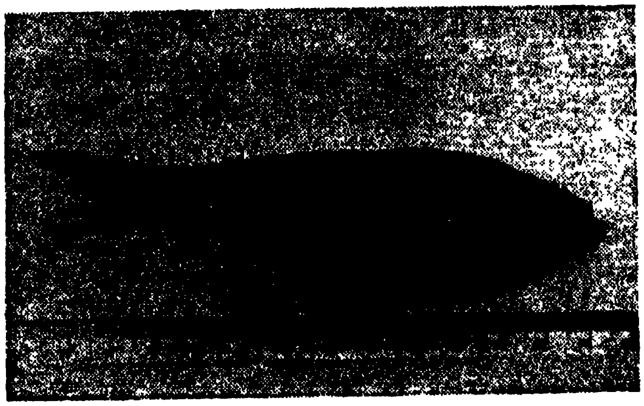

Fig. 1. Deformed specimen of *Puntius filamentosus.*

In *P. filamentosus*, the dorsal fin commences midway between the snout and the base of the caudal fin and some of the fin rays are elongated and filamentous in males, particularly during breeding season.[1,2] The present specimen was quite conspicuous by the total absence of dorsal fin. This is the first instance of absence of dorsal fin in this species. The specimen in question measured 135 mm in total length and 105 mm in standard length. Other morphometric measurements are : head length 28 mm ; body height 35 mm ; depth of caudal peduncle 15 mm ; snout length 7 mm ; eye diameter 7 mm and height of head 20 mm. It was in breeding colouration. On dissection, it was found to be a female specimen in gravid condition (V stage). Except for the complete absence of dorsal fin and a slight depression on the dorsal body contour, this specimen was quite normal in all respects.

Instances like absence of pelvic fin[3,4], reduced dorsal fin[5], abnormal anal[3] and caudal fin[6,8] are reported in a variety of fishes.

Deformities in fins are liable to affect the mobility of the fish, which will reflect on its health and growth. The present specimen was quite healthy and also had attained sexual maturity, indicating that this handicap had not affected it seriously. From the absence of any sign of scar on the body at the dorsal fin region, it can be safely assumed that it is not a case of mechanical injury. Moreover, fins are known to regenerate in short time if severed even at the base level.[7] So, the deformity observed in the present case may be due to developmental disorder.

The author is grateful to Dr A. G. Jhingran, Director, Central Inland Capture Fisheries Research Institute, Barrackpore, for his interest and encouragement. His thanks are due to Shri C. Selvaraj, Scientist-S3, for his kind help.

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Received : 11 April, 1988.
Revised : 12 September, 1988.

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Aorta lipids during ascaridiasis in Cockerels

Studies on lipids during ascaridiasis indicate that those of host serum are not affected,[1] however, liver glycogen level falls.[2] Depletions in some lipid fractions of certain tissues of Rhode Island Red cockerels during the larval span of the parasite has been observed.[3] On the similar lines the present investigation was taken up.

The material included birds of two age groups, group I (G-I) 85 day and group II (G-II) 35 day old chicks at the time of experimental infection. Chicks were divided into 38 & 77 experimentals and 23 & 40 controls for each group, respectively and kept in separate sheds after infection under similar environmental conditions. In each age group 3 chicks were kept as normal where no treatment was given and sacrificed on one day (G-I) and zero day (G-II) after infection. The eggs were obtained from the gravid nematode females and incubated to the infective stage larvae inside the egg. About 4000 such eggs (including those larvae which had come out of the shell) were given to each experimental chick with the help of a cannula. Thereafter the cockerels in the ratio of 6/7 experimentals and 3/4 controls were sacrificed on 4, 11, 18, 25, 32 & 52 day (G-I) and on 2, 4, 8, 12, 17, 22, 28, 32, 40, 45, 52 & 60 day (G-II) after infection samples of aorta from the thoracico lumbar region were weighed and preserved in 2 chloroform : 1 methanol. Lipid extraction has been done by the method of Folch *et. al.*[4] The quantitative estimations included free fatty acids,[5] cholesterol,[6] triglycerides[7] and phospholipids[8]. The statistical significance has been calculated by applying student's t-test.

The total lipid contents (Fig. 1) in group I fall from 4th to 52nd day in experimentals which is statistically significant on 11th and 25th day only. Likewise the significant falls for cholesterol, free fatty acids, triglycerides and phospholipids are indicated in Fig. 2 to 5. The triglycerides indicate significant falls alongwith significant rises on 4, 25 and 32 day (Fig. 4).

In group II (Figs. 6 to 10) except the free fatty acids all the fractions and the total lipids indicate statistically significant falls throughout the experimental period.

The total lipid contents and four major lipid fractions of aorta are negatively affected during most of the experimental period in both the groups except significant depositions in the triglyceride contents of group I cockerels. The effect seems to be age related as it is more prevalent and consistent in the lower age group as compared to the higher age group. This age related effect could be due to the fact that older birds are more resistant to infection.[9] Once the infection establishes in the higher age group birds, the metabolic rate of the latter seems to be better adjusted to the parasitic effect as compared to the youger ones.

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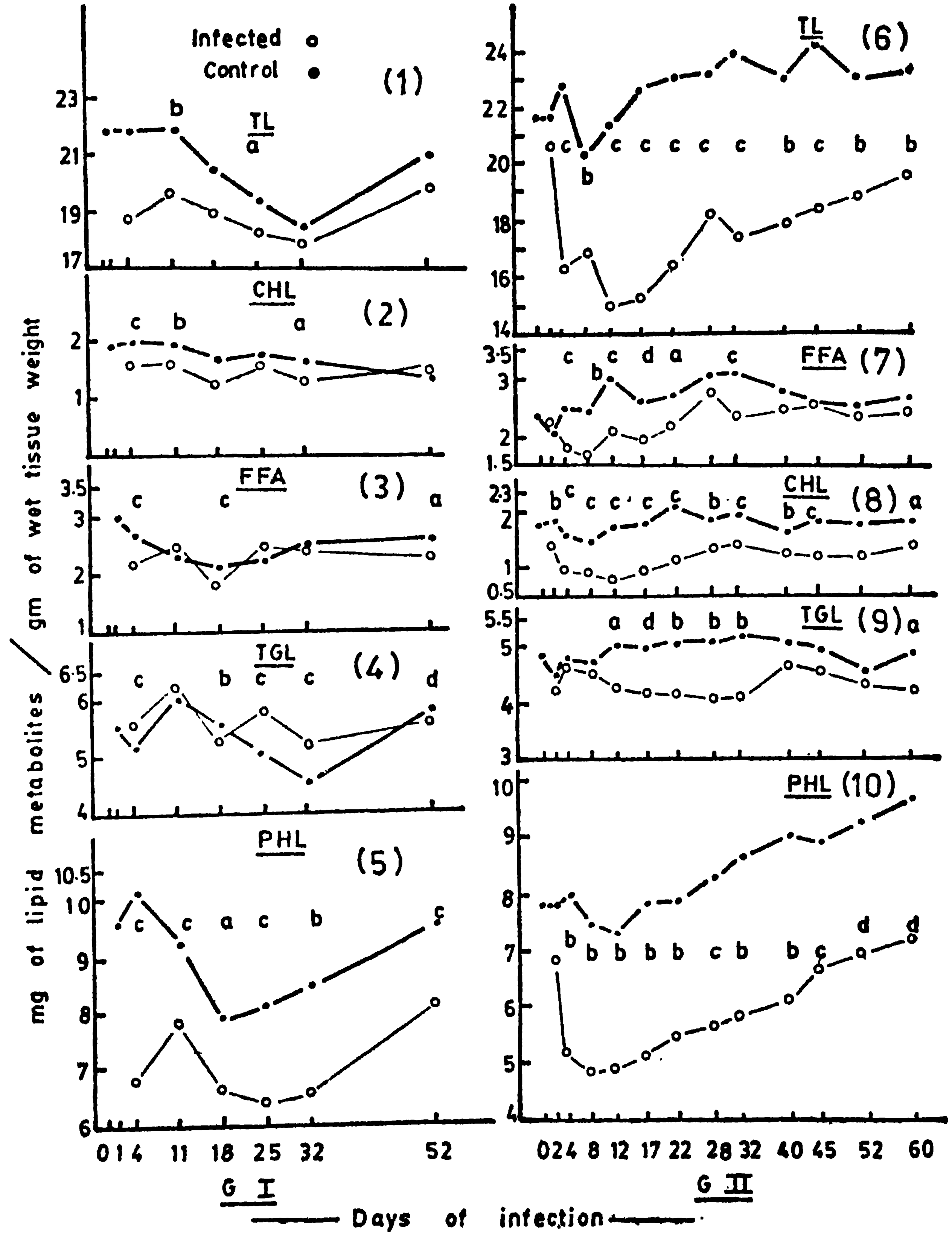
Received: *14 December, 1987.*



Figs. 1-10 : Aorta lipid metabolites on different days of experiment in infected and control chicks. Statistical signicfiance is also indicated. TL—Total lipids, FFA—Free fatty acids, CHL—cholesterol, TGL—Triglycerides, PHL—Phospholipids. a = p <0.05, b = p<0.01, c = p<0.001 and d = p<0.02.

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Lysosomal Cathepsin L : A significant enzyme in relation to human health and disease

As far as we know, lysosomes are the only cellular compartment with sufficient amount of enzymes for degradation of all classes of macromolecules. Lysosomal proteinases have been the subject of several recent reviews as they are believed to be involved in several important phsiological and pathological processes[1-3]. Among others, these proteinases play role in the turnover of intracellular proteins, and other conditions such as tumor invasion and cartilage destruction. It also play a role in the break down of immune complex taken up by the cells. These processes has been studied in various normal cells and of those suffering from lysosomal storage diseases.[4] It is also believed that lysosomal proteinases play key roles in a number of catalytic events in inflammatory sites.[5]

Its importance was first recognized in the last decade of nineteenth century when it was discovered that the chemical composition of all mammalian tissues changes on storage even under bacteriostatic conditions. These changes were ascribed in terms of *enzyme activity*.[6] The proteinases have been classified as serine proteinase (EC 3. 4. 21), thiol proteinase (EC 3. 4. 22), aspartyl proteinase (EC 3. 4. 23), and metallo proteinase (EC 3. 4. 24) on the basis of the essential groups in the active site of the enzymes as serine, thio (or cysteine), aspartic acid, and metal ion(s), respectively.

The term *cathepsin* is usually reserved for those proteolytic enzymes which are lysosomal in origin, means 'to digest' was given by Willstatar and Bamman.[7] Among lysosomal proteinases, the lysosomal cysteine or thiol proteinases are the most active enzymes in the body which hydrolyze more peptide bonds than others

Numerous types of cathepsins have been discovered so far, but the precise molecular mechanism(s) by which proteins are broken down in the cells are unknown yet. Cathepsin L (EC 3. 4. 22. 15) is one of them that belongs to a most important superfamily of three intracellular lysosomal cysteine proteinases comprised of cathepsins B, H and L. Cathepsin L was first identified by Kirschke *et al*[8]. in rat liver. This enzyme is of particular interest to study protein turnover in the body since it possesses higher degradative activity towards selective proteins and polypeptides as compared to other cysteine proteinases[9,10]. Although cathepsin L has been purified from various sources like human, rabbit and rodent livers, and rat kidney and muscle ; but very little information is available regarding its structure-function relationship to human health and disease. It is due to the fact that cathepsin L is relatively difficult to isolate and purify on one hand, and the lack of specific substrates to study its function on the other.

It has been reported that capthepsin L has stronger endopeptidase activity than cathepsins B and H. It degrades myofibrillar proteins and digests many phyiological substrates such as collagen[11]. It has been detected in the lysosomes characterized by its particularly high activity in degrading short-lived cytosol proteins. The substrates earlier used for cathepsin L assay (e.g. Bz-Arg-NH_2, Z-Lys-$OPhNO_2$ and Z-Phe-Arg-NMec) were creating confusion because they are also degraded by cathepsin B, though there are large differences in their specific activities and K_m values[2]. At present azocasein has been proved to be a good substrate for the routine assay of cathepsin L activity. The other substrates which have been suggested for the assay of cathepsin L are myofibrils, the troponin-tropomyosin complex[12].

Among different tissues, cathepsin L is present in relatively larger amounts in liver, kidney and spleen ; though it is present in almost all the organs, by and large. The enzyme requires the integrity of a thiol group for the expression of its biological activity[13]. The increase in catheptic activity in the presence of thiol reagents and EDTA (a chelating agent) indicate the involvement of its free sulfhydryl group in the catalytic process. Chicken liver cathepsin L exists of two polypeptides with molecular weight values of 28,000 (heavy chain) and 5,000 (light chain)[14], whereas bovine brain consists of two polypeptide chains with 25,000 (heavy chain) and 5,000 (light chain)[15]. Human liver cathepsin L has been purified and shown to be similar to the enzyme from rabbit, rat liver and bovine brain by a number of criteria[16]. The molecular weight of cathepsin L from various sources comes in the range of 21,000-30,000. Complete amino acid sequence of cathepsin L is not known.

Cathepsin L preferably hydrolyzes proteins whereas its sister-enzymes (cathepsins B and H) are mainly active on synthetic substrates and peptides[2]. Cathepsin L is somewhat similar to the cathepsin S because azocasein has also very high activity with this enzyme. The pI (isoelectric point) value for cathepsin L is moderate (5.5-6 1) and the pH optimum is 6.5. The enzyme is stable from pH 4 5-6.5, but extremely unstable above pH 7.5.[12] The enzyme is stable at physiological temperature (about 37°C), but gets inactivated beyond 45°C. The carbohydrate content, proper tissue distribution, hydrodynamic properties and various other molecular and catalytic as well as immunological properties of the enzyme are not available to the greater satisfaction. However, some inhibitor studies in relation to this enzyme has been worked out[12]. Very currently, the properties of brain lysosomal cathepsin L and its specificity towards neuropeptides has been defined[17].

The findings that the enzyme (cathepsin L) is very sensitive towards physiologically important parameters such as temperature, pH and ionic strength etc., and can be inhibited or activated in the presence of different compounds, may be of physiological importance since after endocytosis and autophagy of cellular components the enzyme comes into contact with a variety of substances during these processes. It has been reported that cathepsin L is the most powerful enzyme among all cathepsins discovered so far. Evidences are available that thiol proteinases play an important role in break down of immune complex taken up by the cells. Furthermore, it is thought that lysosomal proteinases play a key role in a number of physiological and pathological events in inflammatory sites such as ischaemia, inoxia and hypervitaminosis. Its tissue levels are altered in muscular dystrophy and in malinancy. But very little information is available concerning the mechanisms for these processes on biosynthetic pathways.

Now it becomes evident that lysosomal cathepsin L is far more important than what has been considered so far. At present, a lot of attention is being devoted in order to understand the possible structure-function relationship of this crucial enzyme for its physiological and pathological processes *in vitro* and subsequently *in vivo*. And this makes us to say that the enzyme is significant in relation to human health and disease.

We gratefully acknowledge the C.S.I.R., New Delhi, for providing financial assistance. We are thankful to Dr. M. Y. Khan for his expert guidence.

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Received : 24 February, 1988.
Revised : 24 June, 1988.

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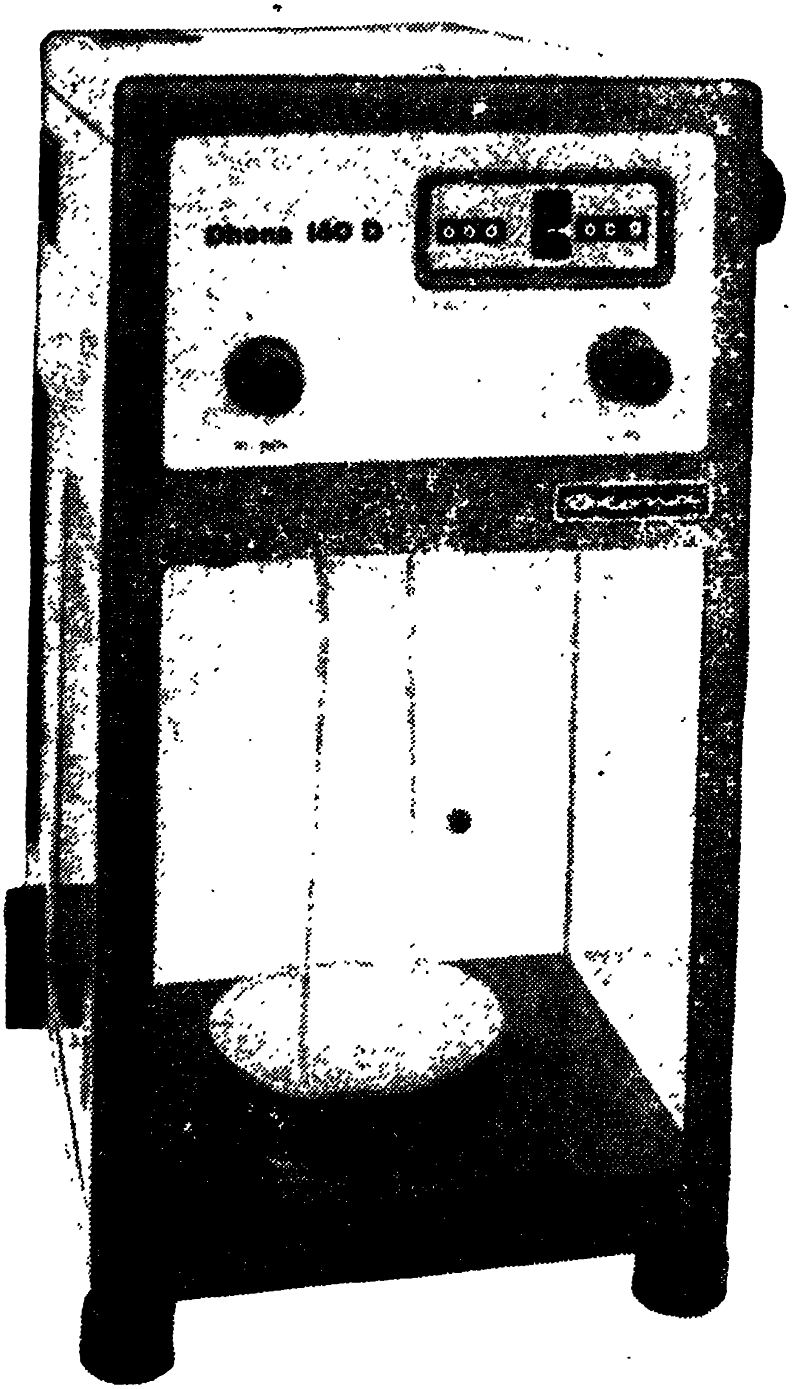

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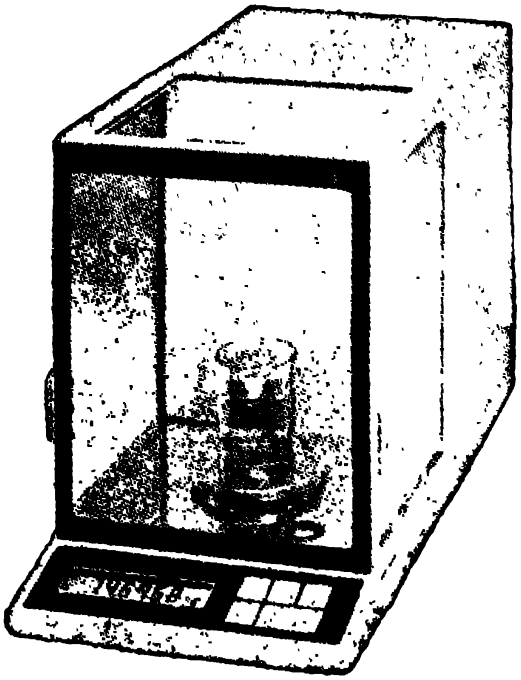

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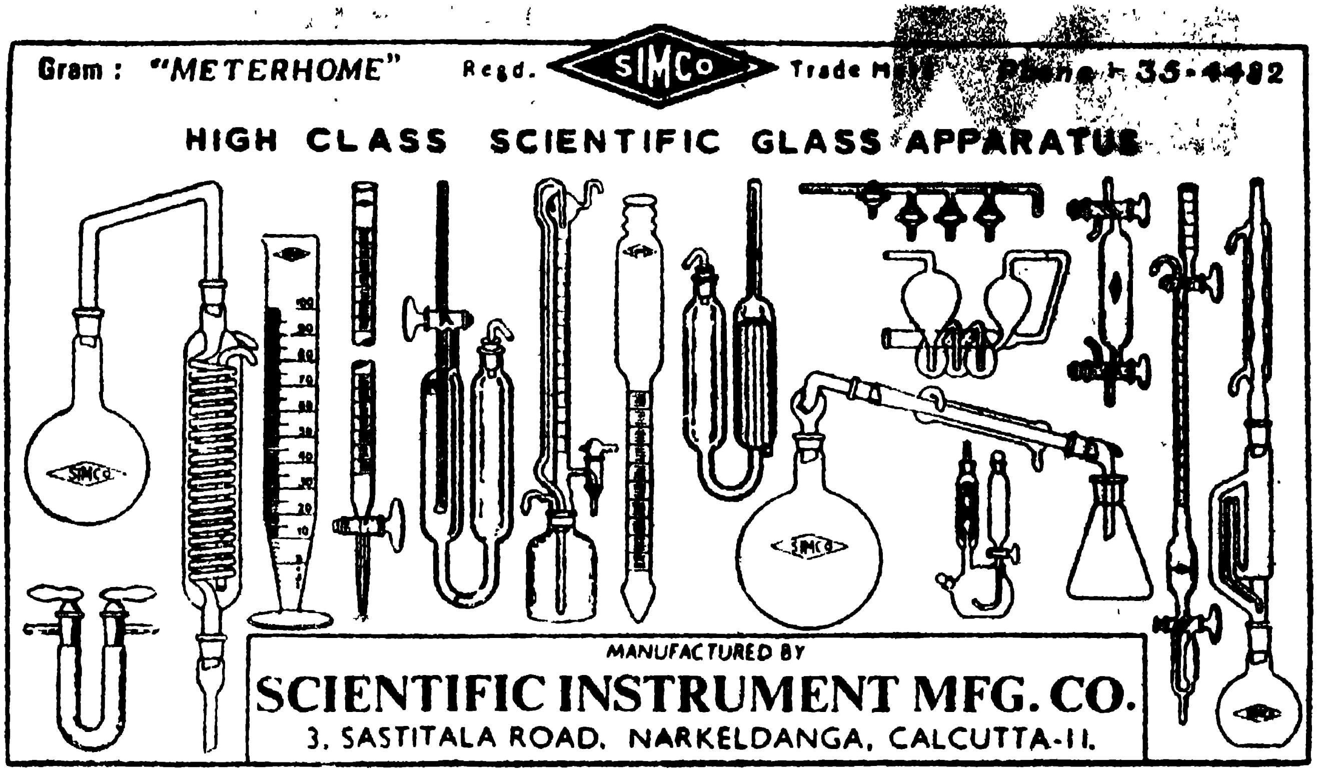

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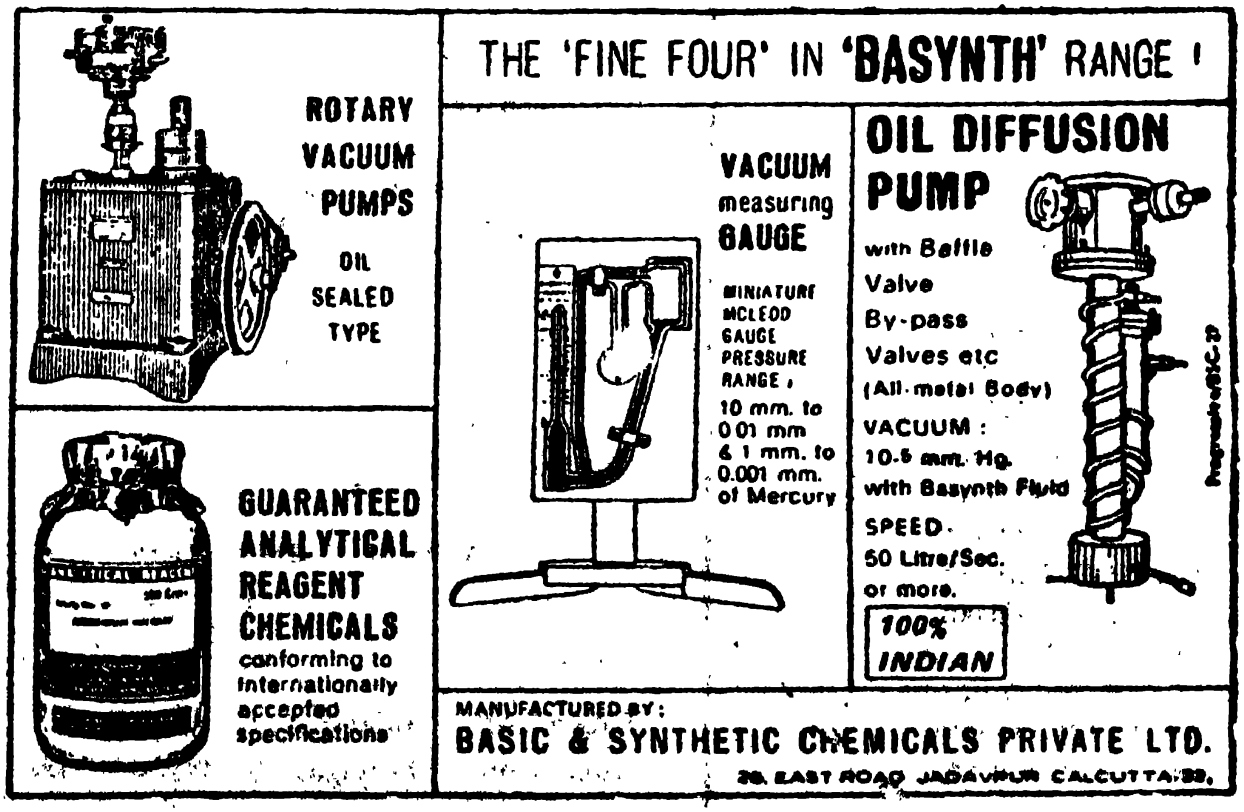

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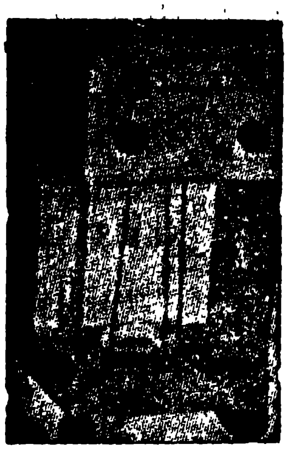

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TODAY, the progress of any country in the world is measured in terms of the units of energy consumed per capita by its citizens. Our sources of energy in the first half of the present century, and to a greater extent even today, are based on fossil fuels, stored by nature for millions of years. With this increasing scramble for more energy, the fossil fuel reserves are dwindling rather fast. India was bestowed with enough coal reserves and hydro-power potential at the time of independence in 1947. The first prime minister Jawahar Lal Nehru had envisaged in those early days itself to build up our energy reserve so that the country could march ahead along with other industrialised countries. All the potential hydro projects were exploited and a number of new larger thermal power station were built. But it was contemplated at that time itself that our energy sources would not be sufficient and newer modes of energy generation have to be looked into. The nuclear energy generation was afresh proposal in those early days of independence and we went for exploring this new found avenue. Today in the 40th year of the independence and in the year of the centenary celebration of the birth of our first prime minister, these efforts have started bearing fruits. The scientific attitude cultivated towards solving power problem of the country has culminated in the eraction of several super thermal power stations at the pit-heads (this was not planned at independence) which feed the national grid. Slowly but steadily the nuclear power industry has also picked up and contributing again to the national grid, the latter effort was the explicit desire of Nehru that we should explore this source fully.

This month the first unit of the Narora (in Uttar Pradesh) Atomic Power Project attained criticality. This is a milestone for Nuclear Power Corporation. The Narora Unit is a symbol—a forerunner of standard 235 MWe Nuclear Power Unit. A stable power supply from this unit will be available to the Nothern grid around September 1989. Work on identical unit 2 is nearing completion. The 470 MWe will be generated by these two units.

The Nuclear Power Corporation was brought into existance last year to efficiently usher the country in its nuclear power programme and attain its set goal towards the end of the century. It is responsible for the design, construction, operation and maintenance of nuclear power stations in the country. It is presently operating three nuclear power stations at Tarapur, Rajasthan and Madras and has got an accumulated operating experience of 50 reactor years.

According to the General Manager of the Corporation Sri E. L. Kati "standardisation of the Narora unit enables the Corporation to reduce the construction periods of the future projection as well as manufacture and delivery time periods of major items of equipments and components such as calandula, endshields, steam generators, heat exchangers and pumps ... Units under construction at Kaiga (in Karnataka) and in Rajasthan and subsequent new projects are targeted for completion in about 8 years".

Narora power plant has been designed in the background of Three Mile Island leak and the Chernobyl disaster. Hence its design incorporates two independent fast acting shut down systems, high, intermediate, and low pressure emergency core cooling system, to meet short and long term requirement and double containment of the reactor building. Further the cooling water to all the heavy water heat exchanger is maintained in a closed loop, so that any failure in these do not lead to escape of radioactivity. The station will also maintain a waste management plant, waste burial facility within the plant area. The site of Narora has seismic nature (Zone III and IV) and has alluvial soil which have been fully taken into account and provided for in design and construction. These features of the plant ensure the total safety of the plant personnel, general public and environment itself during the operation of the plant.

The safety and regulatory requirements of a nuclear plant are looked after by an independent organisation known as the Atomic Energy Regulatory Board (AERB) which came into existence in November 1983, and presently Prof. A. K. De is the Chairman of the same. The AERB is responsible to develop safety code guides and standards for the sitting, design, construction, commissioning, operation and decommissioning of the nuclear facilities in respect of both industrial and radiological safety. The Board prescribes limits of radioactive exposures and release of radioactive materials. The Board further reviews the operational aspects of all nuclear reactors' radiation installation, including emergency preparedness plans. In the recent IAEA guide entitled "Basic safety Principles for Nuclear Power Plants" (1988) activities of the regulatory organisation have been listed which are already complied by the AERB. Inspite of all the precautionary steps, it's worth keeping in mind what the above mentioned book states in its preamble "Safety is never absolute in any endeavour. All of life is hazardous in some way .... safety principles do not guarantee that nuclear power plants will be absolutely free of risks but where the principles are adequately implemented the plant will be very safe and still effective in meeting society's needs for abundant useful energy".

Last year much controversy was raised regarding the sitting of Kaiga power plant in Karnataka and the possible environments effects. Even though the Department of Atomic Energy had carefully gone through each and every aspect of the problem and decided upon the site only after assuring the safety of the environment, the public was not taken into confidence, and media were unaware of the safety arguments. At one time it almost threatened the programme since the public opinion was so strongly against it especially in the light of the Chernibyl experience but the

Department of Atomic Energy took hold of the situation and organised a series of exhibitions and seminars open to public for educating the masses on the safety aspects of the power plant envisaged. Slowly but steadily the keen and progressive mind in Karnataka could see reason and the opposition petered out.

It is easier said that there are so many other safer alternative energy sources which can be harnessed instead of nuclear energy. The non-conventional sources such as wind, solar and biomass should be exploited for large scale power generation. But the current indications are that these sources will begin to supply power in any significant manner not before 10-15 years, then too one has to see whether they will be able to meet our requirement. In India the population is expected to increase rapidly in the next 10 years to cross the 100 crores mark. For such a large population even to meet the basic need, the electricity supply would have to grow by about three folds from its present 56,000 MWe installed capacity. It is in this context that the nuclear energy far from being an outcast among resources ought to be the energy source of choice as the technology is well developed, especially for all uses for which electricity is a suitable intermediary.

Thus in the foreseeable future, nuclear power is the only answer that can meet most of answers. Over the years many alternatives have been found out in nuclear energy too. No one can think of deriving new and larger supplies of electricity from conventional reactors which wasted most of uranium put into them, since most of it neither fissioned directly nor transmuted to Plutonium. This is not a serious problem given world uranium supplies, but any serious expansion would lead to difficulties of supplies. Over the last forty years intensive research and constant innovation, all over the world, have allowed the nuclear technology to emerge anew to meet the energy demands of the world. The Superphenix breeder reactor of France, the high temperature gas cooled reactor of the United States or the Slowspoke of Canada have emerged as the new leaders to meet the growing demands of energy. India has already developed its own breeder technology and is poised in a big way to adopt it before the end of the century. In the meantime, the standarised units is a great advancement which will save much time in the installation.

Further in the future are the fusion reactors where the technology has yet to develop. This device is expected to give an essentially unlimited energy. Or are we going to find that operable fusion reactors can never be made to be economic or indeed to function ? Recently the scientific world has got excited about the possibility of cold fusion, the feasibility of which has been tested at two laboratories in the United States. Bhabha Atomic Research Centre immediately embarked on testing the cold fusion in their own laboratories, so that the country may not loose time in harnessing this new scientific discovery. □

B. B. Baliga

BLACK-LEAF SPOT DISEASE OF OIL-SEED BRASSICAS*

K. R. SAMADDAR**

MUSTARD rapeseed are important oil-seed crops of India and grown over an area of 4.5 million hectares (ha) with a production of 3.2 million tons. Mustard and rapeseeds contribute 20% of the total production of edible oil in the country and occupy second position after groundnut. Despite higher yields, the average yield of mustard and rapeseeds is 688 kg/ha in India in contrast to more than 1500 kg/ha in Sweden, Poland and Canada. It is estimated that modern agricultural inputs can substantially enhance the yield potential. From plant pathological view-point, it is now well established that appropriate plant protection measures can increase 33% of productivity of mustard and rapeseeds[1].

The oil-seed brassicas commonly cultivated in India and West Bengal include Mustard (*Brassica juncea*, 2n = 36) and rapeseeds (2n = 20) such as Brown Sarson (*B. campestris* var. *brown sarson*), Yellow Sarson (*B. campestris* var. *yellow sarson*) and Toria (*B. campestris* var. *toria*).

Leaf spot, incited by *Alternaria* sp., is the most destructive disease of oil-seed brassicas in India and West Bengal. All cultivars are highly susceptible, both leaves and pods being affected. The disease causes a substantial reduction in yield and consequent economic loss. Singh and Bhowmik[2] estimated 24.5-71.5% yield loss depending on the severity of leaf and pod infection. Degenhardt *et al.*[3] reported a significant reduction of oil and protein contents of seeds from infected plants. This report dealt with the indentity of the leaf-spot pathogen, epidemiological factors affecting the disease and the control of the pathogen.

Identity of the pathogen

It is well established that *Alternaria* leaf spot of oil-seed brassicas is caused by three different species viz. *A. brassicae* (Berk.) Sacc., *A. brassicicola* (Schw.) Wilts. and *A. raphani* Groves & Skolko. Neergaard[4] and Wiltshire[5] very clearly delineated the three species which are known to be widespread in their occurrence. Petrie[6] recorded occurrence of all the three species separately on the rapeseed crops of Canadian prairies. He further stated that mixed infections of two species are quite common and the symptomotology of the infections by the individual species or in combination are indistinguishable.

Most of the Indian literature concerned with black-leaf spot of brassicas, however, refer to the pathogen as *A. brassicae*[7]. Several other workers in later years also considered *A. brassicae* as the pathogen of leaf spot of oil-seed brassicas[8]. The same confusion exists even in recent times. Yadava[9] and Bhowmik[10] mentioned *A. brassicae* as the leaf-spot pathogen without any reference to other two species. Apparently, the distribution pattern and the identity of the pathogen(s) prevailing in different parts of India are not known. The identity of the causal organism of a disease is a necessary pre-requisite for the initiation of an effective control programme.

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* Presented at the Seminar on 'Regional Imbalance in Agriculture with special emphasis on Oil-seeds' held on November 25, 1986 under the auspices of ISNA.

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The identity and relative frequency of the species of *Alternaria* responsible for leaf-spot disease of oil-seed brassicas and vegetable crucifers (cabbage, cauliflower, turnip, and radish) commonly cultivated in and around Kalyani were investigated. The causal organism was isolated and identified. Out of 185 samples 89.02% were *A. brassicicola*, 6.09% were *A. raphani* and 4.8% were of mixed infections with both *A. brassicicola* and *A. raphani*. None of the samples yielded *A. brassicae*[11]. Kothanur *et al.*[12], in a survey of *Alternaria* species of rapeseed (*B. napus*) in Scotland, found 80% of the samples infected with *A. brassicae*. The percentage abundance of the three species in different agro-climatic zones of India is not known.

Epidemiology

The environmental and nutritional factors affecting growth and sporulation of *A. brassicicola* as compared to *A. brassicae* and *A. raphani* have been studied by Chungari and Weber[13]. The optimum temperature for growth was 25-28°C and host-extract media supported good growth. Sarkar and Sengupta[14] reported the optimum temperature for conidial germination of *A. brassicicola* to be 22-32°C and optimum relative humidity for germination as 90-100%.

Growth and sporulation of *A. brassicicola* in culture were increasingly inhibited with increase in water-stress condition imposed by addition of mannitol. At—50 bar growth and sporulation were 50% and 12% respectively as compared to controls[15]. The optimum germination of the conidia of the pathogen occurred at 25-30°C, pH 6-8 and RH 99-100%. Germination of conidia was inhibited with decrease in water potential of the germination fluid[15,16].

Hyphae and conidia of *A. brassicicola* showed poor survival ability in natural soil and were lysed within 15 and 30 days respectively. Amendment of soil with nutrients of crop residues caused delay in mycolysis of the pathogen in soil[15]. Seed-pathological study of the seed samples of mustard, yellow sarson, brown sarson and toria obtained from local sources indicated the presence of *A. brassicicola* in 30% of the samples. Not a single sample yielded *A. brassicae*[15,17]. The data confirmed previous reports of the seed-borne nature of the pathogen[18,19]. The pathogen is known to be localized in the epidermal cells of the seed coat of cabbage seeds[20]. The localization of the three pathogens in seeds of mustard and rapeseed is not known.

The fungitoxicity of allylisothiocyanate, the hydrolysis product of sinigrin present in the seeds of mustard is well documented[21-23]. Aqueous solutions of allylisothiocyanate were tested for their anti-fungal activity using *A. brassicicola* and two non-pathogens (*Helminthosporium oryzae* and *Curvularia lunata*) of mustard. Allylisothiocyanate significantly inhibited the germination and germ-tube growth of conidia of *H. oryzae* and *C. lunata* but not of *A. brassicicola*. Apparently, the pathogen can tolerate allylisothiocyanate[15]. The internally seed-borne nature of the pathogen further supports its ability to tolerate allylisothiocyanate.

Control

Yadava[9] reviewed the control measures for oil-seed crops and suggested that the higher production of rapeseed and mustard could be achieved through chemical sprays, cultural methods and cultivation of resistant varieties. Bhowmik[10] reported that fungicides such as difolatan and Mancozeb could successfully control the leaf infections. The efficacy of fungicides as foliar sprays was correlated with their persistence ability on leaves. Pal *et al.*[24] reported that Dithane M-45 0.2% and difolatan 0.1% as foliar sprays could control the disease effectively under West Bengal conditions. In our laboratory, several fungicides were tested for their toxicity *in vitro* and ED_{50} doses were determined. Treatment of seeds with ED_{50} doses of Blitox, Copper sulfate, Ziride, Dithane M-45 and Difolatan could successfully eradicate *A. brassicicola* from the seeds of yellow sarson and brown sarson. Experiments with mustard and toria are underway[15]. Beneficial effects of seed treatments have been registered in the cases of radish seed infected by *A. raphani* and rapeseed infected by *A. brassicae*[6].

Despite attempts of development of disease-resistant cultivars of oil-seed brassicas at a number of research establishments throughout the world, little success has so far been made[6,15]. A total of 250 and 520 germplasm of yellow sarson and mustard respectively were tested for resistance against leaf-spot disease. No test entry showed resistance against the disease so far. Annual Report of 1985-86 of AICRPO, however, have claimed finding of some germplasm resistant to leaf-spot disease.

The possibility of biocontrol of the *Alternaria* species on the surface of the host plant needs careful evaluation. In an attempt to test this, the leaf-surface microflora of field grown mustard were isolated and their interaction with *A. brassicicola in vitro* were examined. Several phylloplane microflora of mustard cultivars B-85 and T-59 were antagonistic to the pathogen and produced distinct inhibition zones. Some of the saprophytes isolated from the phyllosphere of rice and lentil were also inhibitory to *A. brassicicola*[26]. This novel approach of control of leaf-spot disease warrants immediate attention.

Recent advances in cell- and tissue-culture techniques have been successfully applied in the development of improved agricultural lines of brassicas in Canada, USA and China. In oil-seed brassicas, embryo culture can be performed with ease at an early stage of development and excised ovules fertilized[27]. Morphogenesis has been reported in diploid and haploid callus cultures of rape[28] and Chinese mustard[29]. Regeneration of plants from diploid protoplasts of rapeseed has also been reported[30]. Protoplast regeneration and stem embryogenesis of haploid androgenic rape bas been reported[31,32]. With these findings, procedures can now be developed for the use of somatic or androgenic cultured cells in screening for disease resistance against *Alternaria* species.

In vitro selection for resistance in *B. napus* against the culture filtrate of *Phoma lingum*, regeneration of plants from resistant callus and persistence of resistance in progenies through seed have been reported[33]. Development of disease-resistant lines of brassicas against *Alternaria* species through selection of *somaclonal*, *gametoclonal* or *protoclonal* variants using toxins produced by the pathogens[34] or their culture filtrates[35] is a distinct possibility. □

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DEBATE ON KAIGA NUCLEAR POWER PLANT*†

As an important part of the seminar, a debate was organised on Kaiga Power Plant. Dr. M. R. Srinivasan, Chairman, AEC, Dr. D.V. Gopinath, Head, Safety Research and Health Science Programme, IGCAR, Kalpakkam, Sri K. Narayan, Chief Engineer, Kaiga project and Dr. K. Siddappa, Professor of Physics, Mangalore University and Secretary, ISRP were the panel members and answered questions raised by the interested participants. More than 300 persons belonging to different walks of life such as people's representatives, Government and Semi-Government officials, Doctors, Engineers, Teachers, Students, Businessmen, Industrialists and Agriculturists participated in the debate.

Smt. Louella Lobo Prabhu :

1. According to Dr. Shivaram Karanth, who is a non-technical person, Kaiga is an earthquake prone area. Since you are a technical person (Dr. M. R. Srinivasan) I thought you should deal with this question.

2. What are the comparative costs of coal, hydel and nuclear powers ?

3. Though we are largely self-sufficient we do import certain amount of uranium and heavy water. Why ?

Dr. M. R. Srinivasan (MRS) :

1. We have involved the best (persons) in the field of geology, siesmology, School of Earthquake and Engineering, Roorkee, Geological Survey of India, Atomic minerals division. According to them this part (Kaiga area) is less prone to earthquakes and is a safe site.

2. Nuclear power is cheaper than coal base power. Tarapur power station has been supplying power at lowest cost compared to any non hydroelectric power in the country. Whenever terrain is suitable hydel power is cheaper than nuclear power. But such terrain is not always available. Coal base power is 30 to 70% expensive than nuclear power, according to an estimation by Japan. Even in West coast and East coast of America Nuclear power is cheaper than coal base power. This relative cost depends on mining and transport operation of coal.

3. We are buying enriched uranium from France for Tarapur and heavy water from Russia for Rajasthan plant in small amounts.

Refering to a poem cited by Mrs. Lobo Prabhu to highlight the need for taking care of environment and forests in such establishments like Kaiga Dr. Srinivasan said that people should not think physical scientists are not caring for forests and environment. Contrary to such misbeliefs they are taking maximum care of the environment.

K. V. Bhakta :

We were shown earlier a slide giving number of deaths due to different reasons. Kindly give the percentage-wise number of people involved in accidents, smoking, etc. and deaths. A similar percentage in the harmful effects of radiation when compared to the total number of people involved in the field.

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*Held at the Seminar and Exhibition on Ionising Radiation and Nuclear Energy, Mangalore, May 30, 1988

†Kind courtesy of Prof. K. Siddappa, Mangalore University.

D. V. Gopinath (*DVG*) :

It is the probabilities of accident that is important rather than percentages. For example 1 in every 200 smokers smoking 20 cigarettes a day will get affected whereas 1 in 20,000 among workers in nuclear installations may get affected.

E. Vittala Rao :

1. How do you (as scientists) propose to control the commercial and political selfish exploitation of your developments, by those groups which are far more powerful and influential ?

2. How do you propose to ensure that the general public is benefited by the sophisticated, scientific developments and not a few elite ?

DVG :

1. The Department of Atomic Energy is established by the Government for the benefit of the people. Most of the activities are diverted towards the use of ionising radiations and nuclear energy for the benefit of the public. Suggestions in this regard to take the benefits to the society in newer ways are always welcome.

MRS :

2. Country's largest establishment Tata Memorial Hospital (at Bombay) is run by the department, which treats all kinds of ailments and people come from all parts of the country. The department supplies isotopes and other nuclear medicine requirements to hospitals throughout the country. We want to enlarge this service in future.

With reference to your first question I would like to add that India is a democratic country. Policies and programmes are not determined by any group of individuals. Programmes are determined by the duly elected people in the Parliament. The most important endeavour of the Department of Atomic Energy is the power production. This is a service and there is no selfishness involved in this endeavour. In Trombay lot of work has been done on plant breeding using radiations. We have evolved some very beneficial varieties of Tordal, Moong, Groundnut, Rice and so forth. In Maharashtra these have been extensively used by farmers. We are trying to extend this benefit to Karnataka, Madhyapradesh and other parts of the country.

National priorities are set up not by individual scientists but by country as a whole and those priorities are to be fulfilled.

M. Narayana Gokhale :

1. In Kaiga during appointing staff can you give preference to the people of Karnataka, more preferably those belonging to the displaced persons due to Kaiga and Seabird ?

2. After Chernobyl accident we read in newspapers all the stored food should be discarded due to radiation but recently Commerce Minister answered in Parliament that import of butter from EEC countries without radiation test is allowed. Previously there was a ban. Is not there any harm ?

3. Is there any possibility of the people working in Nuclear plants becoming impotent ? If so, is there any past event in India ?

K. Narayan (*KN*) :

1. We do give preference to displaced persons while appointing in Kaiga Project provided they meet other requirements. One member of each displaced family in Kaiga Project will be given a job. About 75 families at site and 65 at township are displaced. In some cases we will give training to the persons in these displaced families at Department's cost and absorb them. Already quite a number of local persons have been appointed.

MRS :

1. The Chief Minister (of Karnataka) has assured the necessary support for the proper ehabilitation of displaced people.

2. Extensive sampling and measurement conducted on butter imported from Ireland shows that the (radioactivity) levels are well below permissible limits. A body of 23 experts set up by the Atomic Energy Regulatory Board which consisted of medical doctors, radiation biologists, and other scientists after careful examination reported that activity levels are very low and are safe. Bangladesh and Nepal have discarded the butter because they don't have measuring expertise and scientific base to express the judgement and ascertain the activity. But we are satisfied that the levels are so low as to constitute any danger. Subsequently Supreme Court has appointed a committee which gone through the experts report carefully and recommended that the butter is safe. Supreme court has accepted the recommendation. These activities are not due to Chernobyl but are of general type--Post Chernobyl, perhaps due to weapon explosion. Whatever may be the reason we have the ability to measure the levels. Also, we have written to the Government that while importing such food items (1) Suppliers should indicate the radiation level (2) We should be allowed to take samples and then advice the Customs authorities whether the consignment in question can be allowed or not. It is a service to the country to safeguard radioactive contaminated food getting into the country.

DVG :

3. No. people working in Atomic plants have not become impotent. Minimum level of activity required to cause impotency is 50 rem whereas levels in plants are 0.8 rem only. Hence no such possibility and also there cannot be any other biological damage with this small level.

S. N. Aikal :

1. What is the life span of Kaiga Nuclear Plant ?

2. If it is to be buried, how deep it is to be buried (so that it never raises its head again) ?

3. Where it is to be buried and how it is to be buried ?

G. N. Bhat :

1. Is it true that the cost of disposal of a dead nuclear reactor will be more than the cost of setting up the reactor ?

2. If so, in comparing the cost of nuclear power with the power from other sources like thermal and hydroelectric, whether the cost of disposal of the dead nuclear power plant is taken into account ?

MRS :

I shall answer the questions of Mr. Aikal and Mr. Bhat together : The economic life of a power reactor is 25 years i.e. money spent on the reactor would come back in 25 years. However the physical life is designed for 40 years and with certain replacements it could go upto 50 or 60 years.

The decommissioning cost of a power reactor is 40% of the cost of installing a reactor. This is taken into account in working out the cost of nuclear power while comparing with other sources of power.

While decommissioning, all radioactive fuel is taken out and all highly radioactive parts are either immobilised there itself by pumping in concrete and see to it that those parts are inaccessible or they can be taken out to some other central place where you decommission.

The rest of the site building can be used for other purposes. Each reactor occupies a space of about 42 m in diameter. It is only that part that becomes inaccessible.

Dr. K. R. Subramanya :

1. What is the permissible limit of radiation ?

2. What is the background level around Kaiga at present ?

3. What is the expected level after the nuclear plant goes into operation ?

4. What will be the level if mining of uranium ore near Arabail commenced ?

DVG :

1. The limit for external radiation exposure is 5000 millirem per year for persons working in nuclear establishments and it is 100 millirem per year for general public.

K. Siddappa :

2. The Physics Department of Mangalore University has taken up a project of measuring base line radiation level in the coastal Karnataka from Mangalore to Karwar and Kaiga area. We have started the work in Mangalore area and we will go upto Karwar and Kaiga. The main objective of this work is to provide a base line data that helps for future comparision and to assess the impact of Kaiga plant if any, on the environment.

DVG :

3. Based on our experience at Kalpakkam the radioactivity level will not increase considerably after the commissioning of the plant.

MRS :

4. As of to-day it is not clear whether Arabail is economically viable for uranium mining. We have better uranium reserves at other places like Cuddappah, AP.

Prof. M. R. Gajendragad :

1. How often are nuclear power plants shut-down for repairs and what alternative sources are tapped for ensuring power supply during these periods ?

2. How self-reliant are we in the matter of nuclear fuel and other requirements ?

MRS :

1. Like other industrial plants nuclear power plants also require maintenance. For maintenance we shut-down plants. These shut-downs are well planned. During these shut-down periods, power from thermal and hydroelectric stations will be connected to the grid.

2. We are not dependent on anybody. We are fully self-reliant. However, some small quantities are imported because of economical consideration.

Naveen and Manish :

1. Are our nuclear installations safe from attacks of hostile nations including sabotage ?

MRS :

1. Attacks on reactors can cause concern. But if a reactor is hit by a missile there is no blow up. The radioactivity spreads if the containment breaches. We have provided double containment facility for all our reactors. During their talks in December, 1985, Pakistan's President, Gen. Zia and our Prime Minister, Rajeev Gandhi did agree on oral basis not to attack each other's nuclear installations even in times of war. An agreement draft is being finalised. Globally also these types of agreements are being discussed.

Rathnakara Shetty :

1. What is the amount of nuclear waste from Kaiga power plant and where it will be dumped ? Is there any effect to the surrounding ?

MRS :

1. We are disigning our reactors for what we call zero discharge. The Radioactivity will be contained within the plant's boundary limits. The long-lived activities in the spent fuel will have to be processed at the reprocessing plant and converted into a kind of glass. It will then get encapsulated. As mentioned earlier the two Kaiga reactors produce very little waste. For example, France, with its nuclear power programme of 40,000 MW, is planning to reach 50,000 MW by year 2000 and all the waste created from that programme would be occupying a space less than that of a football field. So the nuclear waste from Kaiga will be very very small.

Narayana Gokhale :

1. Normally paddy seed has a germinating capacity for one year only. Can we prolong this capacity ? Is it tried in any seeds like vegetables, wheat etc. ?

2. What is the radiation received by average viewer of TV 3 hrs. per day, when compared to radiation from nuclear plant ?

Dr. Amla :

1. Germination viability will be destroyed if small dosage is given.

Vysarao Ninjoor :

1. I think the question is about the new variety of seeds developed in BARC. These are the mutants which have a capacity for higher yields. These have been evolved over the years by the use of ionising radiations. But if the radiation dose used is more than required, germination capacity will be lowered.

DVG :

2. The voltage used in black an white televisions are just 3 to 4 KV. It does not produce any X-rays. For colour TVs accelerating voltage is 10 KV and very soft X-rays are supposed to be produced. The exact measurements for Indian Televisions are not made. Persons in control room of a reactor receive practically no radiations and compared to a TV viewer they will receive a less dose. Persons in maintenance operation may receive as much as a TV viewer would receive. We will try to measure the dosage received by the TV viewer to facilitate direct comparision.

K. Vishwanath :

1. It is suggested that percentage of danger posed by things other than nuclear is more. Is it not possible to prevent this ?

DVG :

1. I am sure it should be possible. We should put in efforts there. From coal plants the amount of waste coming out is far more. But we seem to have accepted it somehow. There is plenty of scope to apply the same safety criteria as in Nuclear industry to other conventional industries. I am sure we will have a much better environment then.

S. N. Aikal :

1. The Central Government has clearly expressed and announced the execution of Kaiga project would be cleared only after a national debate on the subject. Kaiga Project authorities say that they are going ahead with the execution of preliminary work. Which is correct ? How the preliminary work could be taken up when the final clearance is not yet given ?

MRS :

1. The project has been cleared. It has been sanctioned. It has been cleared after following all the due processes of clearances which include environmental clearance, forest authority clear-

ance of Karnataka and Central Government. We had an indepth discussion with the Chief Minister of Karnataka, Mr. Ramakrishna Hegde at Bangalore in October 1985 or so, I don't remember the exact date. Dr. Raja Ramanna and many of my colleagues were there. A number of people's representatives from Karnataka including Karwar area were present. The correct position is we are going ahead with the project. We are also holding discussions here and elsewhere in order to explain, educate the people and clear any misconception they may be having.

Ramananda :

1. You said that the Kaiga region is seismically inactive. There are various hydroelectric projects around Kaiga. Will the Kaiga ragion become seismically active because of these projects ? Will there be any assesing techniques of seismic effects ? Please tell us.

MRS :

1. Reservoir induced seismic activity is a subject of great controversy even among siesmologists. But we are aware that such a view point is held. We have also been consulting best seismologists in the country. We will certainly be carrying out studies. In any case we are engineering the reactors to withstand a certain level of seismic activity and are following a sort of play safe approach. I would like to point out that in Japan, which is subjected to much higher level of seismic activity all over the place and much more frequently, nuclear reactors have been operating safely and more of them are being built. It is not that you cannot design and build a reactor to withstand seismic condition ; it is that you must take a note of it. You must allow for it in your design so that there is absolutely no compromise on the safety of the reactor even if there were a seismic disturbance. We know that Ka ga area is seismically inactive. Now the question of reservoir induced seismic activity, if applicable, is also an input that is taken into account. In any event we are designing the reactors to withstand a certain level of seismic disturbance.

U. V. RAO :

If any accident happens, what are the various steps to clear the polluted atmosphere ?

A. C. Narayana :

Is DAE in a position technically to tackle Chernobyl type or any other disaster if occurs in Indian Nuclear plants ? Or may we have to look for Russian help ?

DVG :

I will answer questions of both together : We don't have to look for Russian help. Chernobyl type accidents cannot happen here. Our reactors are not of Chernobyl type, as Dr. Srinivasan made it clear. Design features are different. Secondly there was no double containment in Chernobyl. There is double containment in our reactors. Any type of accident, if takes place, ionising radiations leaking out from the plant is prevented from affecting the people by the double containment. We put in every effort to see that activity does not get released. In remotest possibility of the activity release, we have an elaborate emergency preparedness plan. This has been drawn in Kalpakkam case. This is true in most of the nuclear power plant's case. It is drawn in active cooperation with district and state authorities. The emergency preparedness plan includes continuous monitoring of the activity released in the environment, precaution to be followed and countermeasures to be taken etc. This is available at all times.

M. G Hegde;

1. Have you arranged this sort of seminar and exhibition in Kaiga region ? If so, give particulars.

2. Did you listen to the complaints of local people ?

3. What steps are being taken by the government or DAE to compensate for the destruction of forest wealth in Kaiga Project ?

4. Will you give particulars of rehabilitation measures you have taken for the displaced families at Kaiga ?

5. Where do you bury spent fuel ?

6. Why are you constructing CANDU type reactors which are discarded by Russia, England and Canada ?

7. Power produced is largely used by industrialists and political leaders. So why the power reactors are built in rural places like Kaiga ? Why not in big cities ?

KN :

We have had one exhibition at Karwar about two years ago. It was well attended. We are proposing to take a mobile exhibition in Kaiga area.

DVG :

We are interested in providing all the information in this regard to the public. Mr. Narayan and others connected with Kaiga are always ready to receive any complaint or request from the local people.

Compared to several hundreds of miles of forest land submerging in hydroelectric projects, only a small area of land is required for Atomic Power Stations. Families getting displaced number to only about 140 as stated earlier. They are taken care of. The department is even ready to provide to them training and absorb them. I think all those questions are well answered earlier.

MRS :

I have been to Kaiga. I have been to Mallapur and Yellapur. I met the leading citizens of Karwar and other two villages. We are not destroying the forest. Total land area required for 4 reactors of the project is less than 20 hectares. We are going to acquire 1.6 km and all of that forest will be left intact. We are going to do extensive planting on every piece of land under our control. You can see this in Trombay and Kalpakkam. For other type of power stations much more land is required. The electricity generated here is for the utilisation by the industries in this part of the country and not for the gratification of the people of Bombay or elsewhere. We are trying to do a basic service in providing electricity here for running industry, for running agricultural pumps, for offices, for homes.

DVG :

In respect of the question of CANDU type of reactor I want to say that a lot of wrong information is being spread among the public CANDU reactor was not developed in England or in Russia. CANDU reactor was developed by Canadians. They have not abandoned it. They have updated it. They have built bigger power plants. The CANDU reactor is best suited for our country as it can be operated with natural uranium and can best utilise the limited uranium resources we have.

MRS :

If you want to ask any other questions during lunch time, you can talk to me. □

OBITUARY

S. R. MAITRA

Professor Sushil Ranjan Maitra was born in the district of Faridpur, now in Bangladesh, and passed away on the 20th July, 1988, in Calcutta. He had his school education in Chittagong, and college education in Presidency College, Calcutta. After obtaining M. Sc. degree in Physiology of the University of Calcutta in 1933, he started research under Prof. N. M. Basu in Presidency College on the epidemic dropsy suspected at that time to be caused by some toxin formed in rice due to storage in moist and hot atmosphere of the rice godown. He also collected different verieties of rice from the district of Burdwan and estimated the amino-nitrogen variation in different qualities of rice.

Prof. N. M. Basu identified Prof. Sushil Ranjan Maitra as a potential young man, and with his blessings Prof. Maitra joined the Department of Physiology of the University of Calcutta as a Demonstrator in 1940. With very meagre research facilities in those days, he started work on cobra venom and its active principles with Prof. B. B. Sarkar of the Department of Physiology and Prof. B. N. Ghosh of the Department of Chemistry and made some important publications in 1942. Prof. Maitra and Dr. N. K. Sarkar identified an active principle in cobra venom, named as cardiotoxin, which could stop the heart beating. The physiological studies on cobra venom and its cardio-toxic principle were embodied in D. Phil. thesis of Prof. Maitra, and he obtained D. Phil. degree in Physiology of the University of Calcutta in 1952. His interests also encompassed the study on the active principles of the bark of *Moringa pterygosperma*, known as Sajina. After obtaining D. Phil. degree, he was appointed as a Lecturer in Physiology of the Calcutta University. He subsequently switched his field of interest to another discipline of Work and Industrial Physiology when he had the opportunity on a Palit Foreign Scholarship from Calcutta University of associating himself with the Gymnastikteoretiske Laboratory, University of Copenhagen, Copenhagen, Denmark, under Prof. E. Assmussen. For a short period he also worked in Gymnastik Laboratory, Stockholm, and Max Planck Institute, Germany. After his return, he according to his training and experience abroad, actively organized the research projects on Work and Industrial Physiology and various aspects related to the physiological and biochemical changes caused by graded work, fatigue, etc., which are also dependent on physical efficiency. This was perhaps a turning period in his research career. Subsequently, he was appointed as a Reader in Physiology. Prof. Maitra made significant contributions in this area and was the founder of the research unit of Work Physiology in the University of Calcutta. Realising the importance of the subject, he introduced 'Work Physiology and Ergonomics' and 'Sports and Exercise Physiology' as special papers in M. Sc. Physiology course. Prof. Maitra retired as the Professor and Head of the Department of Physiology, Calcutta University, in 1975. Even after his retirement, he was actively associated with the teaching and research in the Physiology Department.

Prof. Maitra was all along actively engaged in organizing the movement for expansion of Physiology from School to the University level, in developing teaching and research of Physiology as a basic science and also for the propagation and application of the subject as a very useful branch of social science. He served more than three decades the Physiological Society of India as a member of the Executive Committee, Treasurer, General Secretary and President, and Chairman of the Editorial Board of the Indian Journal of Physiology and Allied Sciences, and was the President of the Section of Physiology of the Indian Science Congress Association in 1966-67. Also in a leading role in Science Club movement in West Bengal, he served the Science Club, Calcutta, in various capacities for many years and was its President till his death. He was also the founder of Nripendranath Institution in Tollygunge, Calcutta. Prof. Maitra was a bachelor.

In his death, we have lost one of the most distinguished Physiologists, a true teacher, a social worker and a friend. The marks left behind by him should be properly preserved and developed further by his students and friends to show due respect to the departed soul.

May his soul rest in peace. ☐

A. K. Medda

Notes and news

Vistas in Indian Palaeobotany

A Symposium on "Vistas in Indian Palaeobotany" was jointly organised by Birbal Sahni Institute of Palaeobotany, Palaeobotanical Society and Indian Association of Palynostratigraphers, at the Birbal Sahni Institute of Palaeobotany, Lucknow from November 14-16, 1988.

Research papers were contributed on the focal theme notably on the problems of origin and antiquity of life, fossil fuels, source rock palynology, morphology, taxonomy, evolutionary trends, reconstruction of past vegetation, palaeoenvironments, chemistry of fossil woods, plant remains from pre- and protohistoric times and data retrieval and system analyses.

Microfossils comparable to Upper Proterozoic records are reported from Nainital Synform, Kumaon Himalaya. Microbiota of Suket Shales (Vindhyan Supergroup) suggest an age that is younger than available. K-Ar dates (1400 ± Ma). Evidence of metaphyte/metazoans indicates shelf-like marine setting during Vindhyan sedimentation.

Study of Permian floras of India has brought to light new types of seed and pollen-sac bearing, branched organs associated with ginkgoalean leaves. Dominance of *Glossopteris* and other associated taxa is reported from Barakar Formation of Talcher Coalfield, where the *Gangamopteris-Noeggerathiopsis* complex is absent, unlike typical Barakar megafloral assemblage known so far.

The age of fossiliferous bed exposed on the left bank of Gopad river near Nidhpur village, Sidhi district, M.P., has been a matter of controversy. Predominance of glossopterid leaves and lack of indubitable *Dicroidium* leaves have been taken to suggest a latest Permian age ; *per contra* Triassic affinity is put forth on several other evidences, such as palynofloral pattern and geological setting of the area. The quick and sharp change-over from striate disaccate to taeniate phase in the upper part of Middle Member of Kamthi Formation in Godavari Basin indicates a palynological break. Interestingly this Permian-Triassic transition shows closer affinity with that of Salt Range and Madagascar rather than Damodar Valley.

The Gondwanic palynofloral reflection in Tethys Himalaya and southern China is suggested. The increasing palynological homogeneity during post Permian times as evidenced by global incidence of striate-taeniate and nonstriate-bisaccate pollen is considered to be indicative of warming climatic trends.

The palynological evidences gathered from the eastern side of Brahmani river section of the hitherto considered Talchir Formation in the Talcher Coalfield of Orissa suggests the presence of Jurassic/Lower Cretaceous sediments in the graben.

New plant megafossil evidence from Dubrajpur Formation exposed at Khatangi Hills, Rajmahal Basin ; Gollapalli beds, A.P. and Athgarh Formation, Mahanadi Basin suggests Lower Cretaceous age assignment. Comparative morphologies of Bennettitalean fructifications and *Cordaianthus* prove closer affinities.

Tracing the evolution of angiospermid pollen characters, it is interpreted that infratectal interstitium (TEM) in certain gymnosperms is columellate, manifesting grades of complexity. It is suggested that angiospermid pollen characters exemplified during Triassic were lost (due to extinction ?) and reappeared in the Lower Cretaceous. Data to bridge this gap is wanting.

Reconstruction of idealised vegetational scenarios around Nagpur. Chhindwara and Sahapur on the basis of available information on Deccan Intertrappean flora depicts a tropical, evergreen to semi-evergreen forest similar to present day forests of western ghats. Additions to the Deccan Intertrappean flora have been made through documentation of podocarpaceous ovules, pseudostem and arecoid palm fruit from Mohgaonkalan.

Studies of Neogene palynofloras and fossil woods from Quilon and Ratnagiri areas suggest prevalence of somewhat equable tropical humid climate with heavy rainfall all along the Kerala Coast during Neogene times. The record of Palaeocene-Eocene palynological succession in subsurface of Neyveli and Kerala coast is a significant finding adding new knowledge to the stratigraphy of the east and west coast of India.

Attempts have been made to summarise available palaeobotanical and palynological data from Tertiary sequences of Himalayan region. The data has been utilized to reconstruct vegetational pattern of the terrain during Palaeogene-Neogene times.

Tertiary sequences of Assam, Meghalaya, Nagaland and other areas in NE India have continued to attract attention of palaeobotanists and palynologists for past few decades. Studies of Neogene fossil woods from Assam and Nagaland suggest a close phytogeographical link during that period between Indian subcontinent and South-East Asia. Palynological investigations of surface and subsurface Palaeogene-Neogene sequences of Assam are utilized for building up a broad biostratigraphic framework.

A concentrated interdisciplinary effort involving palaeobotanists, vertebrate palaeontologists, sedimentologists and specialists in palaeomagnetisim is being made to study the Siwalik of Nepal. Palaeobotanical evidences have been brought forward to suggest a humid tropical climate during Lower Middle Siwalik with evergreen to semi-evergreen floral pattern in lower part, changing into a predominantly deciduous forest in younger horizons. Pollen succession of these deposits suggest a palaeoecological set up with fresh-water swampy environment of lower part, gradually replacing upwards to low-land habitat.

Palynological analysis of an organic clay encountered almost at present day MSL in a well on South Kanara coastal plain suggests its deposition in a mangrove setting and helps in monitoring Late Pleistocene sea level changes. The 14 dates older than 40,000 yrs. BP given to this level coincide with warm interstade during Wurmian glacial-event which was characterised by lowered sea level.

Palynological analysis of Late Holocene subsurface material from Coondapur area, Karnataka reveals constant presence of well developed mangrove forest reflecting a lagoonal environment. The cause of absence of mangrove from the site today is land reclamation and indiscriminate felling of wood. The past history of sholas in South Indian montane reveals that the shola forest is almost on the verge of extinction and dire preventive measures are required to save it. Attempts have been made to reconstruct the vegetational history of mangroves in the Chilka Lake.

Organic petrological investigations have suggested that high representation of resinite maceral probably makes Raniganj coals more susceptible to spontaneous combustion. Biopetrological study of Tertiary coals from Assam, Nagaland and Meghalaya indicates that these coals are rich in liptinitic contents and, therefore, also form good source for hydrocarbons. High incidence of such material also suggests better suitability for hydrogenation liquifaction.

Effect of acetylbromide on fossil wood from Karewa sediments indicated that the percentage of acetylbromide soluble matter of fossil woods decreases from 100% in modern to 12% in Pliocene woods suggesting increasing humification during the past four million years. Presence of aminoacids, fats, organic acids, phenols and flavonoids is indicated in fossil woods from Palana lignite, on the basis of paper chromatography test.

New reports of plant megafossils from Lower Cretaceous of East Coast of India were made. Morphological and taxonomical aspects of certain fossil leaf genera were discussed.

Dendroclimatological analysis of deodar trees from Joshimath, U. P. indicate close relationship between ring-width chronology and average monthly precipitation and maximum temperature.

Morphological and taxonomic aspects of GV Types dinoflagellate cysts recovered were critically analysed necessitating creation of a new dinocyst taxon from Turonian sediments of Cauvery Basin.

Institute-University Interaction : A dialogue took place between the University teachers and the Sahni Institute scientists participating in the Symposium to formulate a working plan to promote the science of Palaeobotany in the country. A frame-work document was presented for the proposed interaction which stated that Palaeobotany has undergone much change in its contents and character and more strees is now laid on analytical and interpretative aspects. The existing curriculum should now be reviewed to develop one which takes into consideration the continuous inflow of new data. The current topics, like palaeogeography, palaeoecology, biostratigraphy, evolution, migration of floras, etc., must be introduced in the curriculum.

It was also suggested that an ideal syllabus must be evolved and advance courses should be provided which can cover most of the elementary courses and special courses in Palaeobotany. It was unanimously agreed upon that the gap between research and teaching should be minimised, and well documented authentic teaching material should be produced. The aim can be achieved by collective efforts of the Universities and the Sahni Institute. A group was constituted to undertake preparation of a revised Curriculum. ☐

Birbal Sahni Institute of Palaeobotany

Indo-French agreement on vaccine production

A joint venture and technical collaboration agreement for the setting up of an Indo-French viral human vaccine R&D-cum-production unit was signed here today.

The agreement marks the formal launching of the project proposed by the French nearly four years ago and is the first agreement in the science and technology front as part of the Festival of France in India and the French Presiden, Mr. Francois Mitterand's visit here.

The signatories were the three promoting partners of the unit, namely, the Department of Biotechnology (DBT) of the Government of India. Indian Petrochemicals Corporation Ltd. (IPCL), Baroda, and the Institute Merieux, Lyon, France.

This joint sector enterprise is proposed to be set up in Gurgaon, Haryana, and envisages manufacture of 20 million doses of measles vaccine, 2 m doses of vero rabies vaccine, 50 m doses of inactivated polio vaccine and formulation of 40 m doses of quadruple diphtheria-pertussis-tetanus-polio (DPTP) vaccine a year.

Production in 1991-92 : The project is to be realised on a very tight timeframe in view of the targets to be achieved in the national immunisation programme. The unit is to begin production on commercial lines in 1991-92 with an annual turnover of about Rs. 36 crores.

'Biggest unit' : The undertaking, according to Dr. Alain Merieux, who signed the agreement on behalf of the Institut Mericux, is the biggest new vaccine manufacturing-cum-R&D unit being set up anywhere in the world and for France 'it is a strategically crucial step'. Mr. Hubert Curien, French Minister for Science and Technology, said the French Government attached great importance to the venture.

The agreement entails the transfer of the state-of-the-art technologies for these vaccines by the Institut Merieux which will be totally responsible for the basic engineering of the plant. An Indian group is proposed to be set up, which will have French experts as well, to evolve detailed engineering designs.

The total project cost is expected to be around Rs. 95 crores, including about Rs. 23 crores of foreign exchange component. In addition, the French Government has offered a gift of know-how worth 69 million French Francs. The remaining know-how fee of the order of 32 million French Francs will be met through soft credit which the French Government has agreed to extend.

The technologies selected for the manufacture of tissue culture rabies vaccine and the killed polio vaccine are the so-called vero cell micro-carrier fermentation technology. This rabies vaccine is climed to be highly purified, safe and efficacious requiring only five to six doses of one ml each for complete post-bite immunisation. The conventional sheep brain derived vaccine requires 14 doses of 5 ml each. The polio vaccine is an injectible one, opposite to the currently used oral polio vaccine (OPV), and two doses of IPV are believed to confer 95 per cent to 100 per cent protection to recepients. One of the major advantages claimed of the new vaccine is its thermostability and combinability with the triple DPT antigen to get the quadruple vaccine DPTP.

Regarding field trials in India of these new vaccines, it should be pointed out that the measles vaccine has been in use in the country for long through imports. While the rabies vaccine is available in the Indian market, field trials of 2000 doses of IPV and DPTP have been going on for the last two years in the North Arcot district of Tamil Nadu under the supervision of Dr. Jacob John of CMC, Vellore.

Shortage of OPV : Today there is an acute shortage of OPV in the country and in this context the setting up of an OPV production unit with the Soviet assistance, expected to begin production by 1991, gains significance. According to Dr. S. Ramachandran, Secretary, DBT, the OPV from the Indo-Soviet unit will be put to use in the immunisation programme till the French unit begins its production. He said after the initial immunisation with DPTP, subsequent immunisation after a five year period can be done with the OPV. □

The Hindu

Two areas declared ecologically fragile

The Centre has declared the Doon Valley and the Murud-Janjira area in Maharashtra's Raigad district as "ecologically fragile areas" and banned location of industries there.

A notification issued by the Environment and Forests Ministry said industries listed as highly polluting and placed in the 'red' category will not be allowed to be set up in the Doon Valley.

Similarly, no industry will be allowed in the one km belt from the hightide mark of the Revdanda creek up to Devgarh Point (near Shrivardhan) as well as in the one km belt along the banks of the Rajpuri creek up to Mhasla in Raigad district.

The ban follows reports that industrial activity in the coastal stretch is affecting the ecological balance. The ban does not cover tourism activity.

In the Doon Valley, industrial activity will be restricted, allowing only those non-polluting units that fall under the "green" category.

Industries listed under the "orange category" will also be allowed on a 'selective basis', provided pollution control devices are installed. □

The Hindu

Forty-five litres down the drain daily

Leaking taps speak of the most shocking things about water. And about ourselves.

Every day in Delhi, people waste nearly 275 million litres of water. In the country, a person wastes on an average 45 litres per day.

—Water that could quench the thirst of one-fourth of all the villages in Rajasthan.

—Water that could turn 13,200 hectares of barren land into fertile farms.

—Water that needs the labour of thousands of people and the efforts of several official agencies before it reaches us in a safe form, only to be wasted.

Every time a tap is left running while brushing your teeth, you waste as much as two litres of water : nearly 60 litres a month—enough to allay the thirst of 30 children in a remote village somewhere.

And water wasted, while you soap yourself, is enough to meet the daily drinking water requirements of a family of five in a city like Delhi. □

The Statesman

Computer ailments

The computer screen, the apparently harmless Video Display Unit (VDU), emits electromagnetic rays, radiant energy and heat, causing falling eyesight and cataract, body pains, miscarriage and birth defects.

Describing the strain resulting from 6 hr/day routine in front of the computer terminal as an "occupational disease", experts of the Computer Society of Zimbabwe reported that the problem had worsened in developing countries as computers are a new technology there and health regulations are not adhered to.

Medical check-up before working on the computers are not carried out in most cases. Doctors in these countries are not even able to diagnose and relate the VDU-related problems to their cause, they said.

Radiant energy from VDUs has been linked in American and Australian studies with eye cataracts, while the flickering of screens has been found to bring on a form of epilepsy.

VDU workers have also recorded an increase in skin and face rashes resulting from the electric charge on the face of the screen.

A recent study in the USA has revealed that working on the terminal for more than 20 hr/week doubles the number of miscarriages among women workers. Women often carry out the most respective computer functions with long hours of word-processing work previously done on the typewriters.

Not all health problems are because of the screen. Journalists and office workers in the USA and Europe have recently been complaining of painful cramps in the hands, arms and shoulders called "repetitive strain injury". With these workers striking the keyboard sometime more than 45,000 times an hour, the hand movements can tear and inflame the muscles and tendons leading to life-long disability. ☐

The Statesman

Ugly potatoes show promise

Using cell fusion, researchers at the University of Wisconsin, Madison, USA, have developed fertile potato hybrids resistant to two serious potato diseases. According to the researchers, this is the first time that cell fusion has successfully produced fertile hybrids of a major food crop species. Some of the hybrids are resistant to potato leaf-roll virus, an aphid-borne disease reducing yields by 30%, others resist bacterial soft rot causing annual losses of up to $ 100 and some resist both diseases. The dual-resistant hybrids are able to sexually cross with potato cultivars and pass resistance to the next generation. According to plant pathologist John Helgeson, whose laboratory conducted the research, resistant hybrids will now be given to plant breeders, who hope to cross the plants with commercial potatoes to produce marketable varieties. The hybrids could not be marketed as they are now, adds Helgeson. "Some of our materials aren't the most appetizing-looking potatoes." ☐

Bioscience

Letters to the editor

Nitrogen economy for wheat due to the effect of preceding crops

Legumes are known to increase soil fertility, particularly soil nitrogen. Thus introduction of nitrogen fixing leguminous crops either as green manure or for grains in the rotation can provide substantial quantities of nitrogen to the succeeding crop.[3,4] A field experiment was conducted to study the effect of rainy-season crops and incorporation of their residues into the soil on the succeeding crop of wheat (*Triticum aestivum* Linn. emend. Fiori and Paol).

During the rainy seasons of 1980 and 1981 'V 16' Cowpea [*Vigna unguiculata* (Linn.) Walp. Subsp. cylindrica (Linn.) Van Eseltine] and 'Ganga 5' maize (*Zea mays* Linn.) were grown for grain and fodder with recommended farm production practices. Another plot was kept as fallow during the rainy season. The treatments for both the seasons are given in Table 1. After the crops were harvested, their residues were incorporated into the soil and 'HD 2204' wheat was grown in winter at 3 levels of nitrogen (0, 60 and 120 kg/ha). The soil of the experimental site was sandy loam with 0.0475% total N, 10.2 kg of available P and 131.7 kg of available K/ha. Its pH was 7.9. The recommended doses of 20 kg N, 60 kg P and 40 kg K/ha were given to cowpea and 120 kg N, 50 kg P and 40 kg K/ha to maize. A basal dose of 60 kg P and 50 kg K/ha and half of the N as per treatment were applied to the wheat crop at the time of sowing. The remaining half of the nitrogen was top dressed after the first irrigation.

The pooled data (Table 1) indicated that when wheat, which gave a grain yield of only

TABLE 1 : Grain yield (q/ha) of wheat (pooled) as affected by the interaction between preceding crops and N levels

Preceding crop	Nitrogen level (kg/ha)			
	0	60	120	Mean
Fallow	32.15	41.41	48.65	40.74
Cowpea for grain, fodder ploughed in	34.89	46.95	55.12	45.66
Cowpea for grain, fodder removed	33.31	45.54	54.22	44.36
Cowpea for fodder	39.20	51.72	57.89	49.60
Maize for grain, fodder removed	31.15	41.59	48.82	40.52
Maize for grain, fodder ploughed in	32.97	41.33	49.05	41.12
Maize for fodder	33.33	43.27	50.34	42.31
Mean	33.86	44.54	52.01	43.47

	SEm±	C.D. at 5%
Nitrogen levels at the same rainy-season crop	0.6532	1.84
Rainy-season crops at the same level of N	1.046	3.00

40.74 q/ha when grown after fallow, yielded 42.31 q/ha when grown after maize for fodder and 49.60 q/ha when grown after cowpea for fodder. The grain yield of wheat with 60 kg N/ha following cowpea for fodder was as good as that obtained with 120 kg N/ha following maize. Linear and quadratic components as tested by variance ratio show that grain yield of pooled data exhibited a quadratic response (T_4) to N fertilization indicating thereby that the response followed the low of diminising return (Table 2). The contribution of cowpea fodder to the yield of wheat was the highest as would be having the highest 'b' value (0.4282). The optimum dose of N was found to be 84.9 kg/ha for wheat succeeding cowpea for fodder.

TABLE 2 : Response of nitrogen as influenced by preceding crops

Preceding crop	Response equation	'X' optimum (kg/ha)	'N' required for targeted yield of 45 q/ha (kg/ha)
Fallow	$Y=32.4850+0.01376\ x$	linear	93.00
Cowpea for grain, fodder ploughed in	$Y=35.5500+0.1685\ x$	linear	58.00
Cowpea for grain, fodder removed	$Y=33.9017+0.1742\ x$	linear	63.00
Cowpea for fodder	$Y=39.2000+0.4282\ x-0.0023\ x^2$	84.9	21.00
Maize for grain, fodder removed	$Y=31.6933+0.1472\ x$	linear	91.00
Maize for grain, fodder ploughed in	$Y=33.0800+0.1340\ x$	linear	91.00
Maize for fodder	$Y=33.8117+0.1418\ x$	linear	79.00

x=Unit of nitrogen (kg/ha)
Y=Unit of yield (q/ha)

The amount of nitrogen saved in terms of residual nitrogen in one cropping system over the other is referred to as nitrogen economy[1]. Using the response curves, nitrogen economy was calculated. Table 3 reveals that cowpea grown for fodder preceding wheat crop resulted in a maximum N economy of 48 kg/ha, confirming the earlier report[2]. Apparently, more N was left in the soil by cowpea than by maize. The study indicates that there is a great

TABLE 3 : Nitrogen economy for wheat due to the effect of preceding crops

Preceding crop	Succeeding crop	'N' economy (kg/ha)
Cowpea for grain, fodder ploughed in	Wheat	22
Cowpea for grain, fodder removed	Wheat	11
Cowpea for fodder	Wheat	48
Maize for grain, fodder ploughed in	Wheat	4
Maize for fodder	Wheat	10

possibility of increasing wheat yields and economising fertilizer use by incorporation of residues of preceding crop of cowpea into the soil. ☐

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Received: 17 August, 1987

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Electronegativity equalization in glycine and glycinepeptides

A significant development in the electronegativity concept has been provided by Sanderson formulation of the principle of Electronegativity Equalization[1,2]. Recently Bratsch[3,4] described a method for the calculation of equalized electronegativity (X_{eq}) and the estimation of partial charges on various groups using Pauling Electronegativities as determined by Allred[5]. Keeping in view, the importance of amino acids and peptides as ampholytes, the application of Bratsch method to amino acids and peptides showed that electronegativity equalization occurs in case of amino acids and peptides.

Amino acids and peptides exist as cations, zwitterions and anions depending upon the pH in aqueous medium. The data (Table 1) show that X_{eq} values for glycine and glycinepeptide

TABLE 1 : X_{eq} values and group partial charges on glycine and glycinepeptides

Compound and pK values (pK_{COOH}, pK_{+NH_3})	Partial charge on groups											
	Cationic				Zwitterionic				Anionic			
	COOH	NH_3	CH_2	CONH	COO	NH_3	CH_2	CONH	COO	NH_3	CH_2	CONH
glycine	−0.13	0.59	0.54	–	−0.54	0.26	0.28	–	−0.78	−0.18	−0.03	–
(2,36, 9.56)		X_{eq} = 2.714				X_{eq} = 2.52				X_{eq} = 2.297		
glygly	−0.22	0.47	0.44	−0.12	−0.54	0.26	0.28	−0.30	−0.67	−0.04	0.11	−0.50
(3.13, 8.07)		X_{eq} = 2.643				X_{eq} = 2.52				X_{eq} = 2.388		
glyglygly	−0.27	0.42	0.40	−0.17		Same as above			−0.63	0.01	0.16	−0.43
(3.20, 7.89)		X_{eq} = 2.61								X_{eq} = 2.43		
glyglyglygly	−0.29	0.39	0.37	−0.20		Same as above			−0.61	0.04	0.19	−0.40
(3. 21, 7.87)		X_{eq} = 2.593								X_{eq} = 2.454		
glyglyglyglygly	−0.31	0.37	0.36	−0.21		Same as above			−0.59	0.06	0.21	−0.38
(3.39, 7.86)		X_{eq} = 2.581								X_{eq} = 2.468		

species follow the order : cationic > zwitterionic > anionic. It is evident that with the increase in chain length from glycine to pentaglycine (glyglyglyglygly), X_{eq} values decrease for cationic species remain constant in case of zwitterionic species and increase for anionic species. Considering the pK values of glycine and glycinepeptides[6] and present X_{eq} values, it is obvious that greater the X_{eq} values of cationic species, lesser is the pK of $-COOH$ group. Similarly, lesser is the X_{eq} value of anionic species, greater is the pK value of NH_3^+ group.

Cationic species : In case of glycine, $-COOH$ group has negative charge whereas $-NH_3$ and $-CH_2$ groups positive charge. A decrease in the positive charge on $-NH_3$ and $-CH_2$ groups and increase in negative charge on $-COOH$ and $-CONH$ groups was observed with increasing chain length from glycylglycine to pentaglycine.

Anionic species : Increasing peptide chain length enhances the positive charge on $-CH_2$ group whereas the negative charge on $-COO$ and $-CONH_2$ group decrease.

Zwitterionic species : The magnitude of the charge on $-COO$, $-NH_3$, $-COOH$ and $-CH_2$ groups remains constant irrespective of the peptide chain length. □

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Ageing of intact sunflower leaves : Changes in leaf pigment, protein, amino acid and membrane lipid paroxidation

Sequential ageing of leaves of higher plants has long been investigated in terms of the content of chlorophyll and protein[1-3]. However, lipid metabolism of leaves during ageing and development has not been studied in detail. Secondly, peroxidation of thylakoid lipids has been extensively investigated during ageing of cell free chloroplasts,[4] but such studies have not been made in intact leaves. The present work is therefore, aimed to investigate peroxidation of chloroplast lipids during leaf development and senescence of sunflower plant.

Sunflower (*Helianthus annuus* L.) plants were grown under natural field conditions in the botanical garden of Sambalpur University. Uniformed-sized leaves were collected from 2nd, 4th, 6th, 8th, 10th and 12th nodes from apex for experiments.

About 10-15 leaves were taken from each node from plants of identical age and homogenised in a chilled mortar with a pestle in ice-cold isolation medium containing 175 mM NaCl and 0.05 M Tris-HCl buffer (pH 7.8). After homogenisation, the homogenate was squeezed through 16 layers of cheese cloth. The filtrate was centrifuged at 500 × g for 1 min. The supernatant was again centrifuged at 1500 × g for 10 min and after centrifugation the pellet was collected by suspending it in a small volume of homogenising medium. From the chloroplast suspension, 0.5 ml of aliquotes was taken for MDA (malondialdehyde) measurement. All the experiments were conducted at 4°C in green light.

Leaves were ground in 80% prechilled acetone and chlorophyll was estimated following the method of Arnon[5] and the carotenoids according to Liaaen-Jensen and Jensen[6]. Leaf protein was estimated by the method of Lowry *et al.*[7] using BSA (Sigma fraction V) as the standard. Amino acid was estimated according to Yemm and Cocking[8] using glycine as the standard. The amount of MDA accumulated was estimated by Heath and Packer[9]. Absorbance was measured by double diffusion technique by the method of Thomas and Nagraja[10].

Changes in the content of pigments (Chl. a, Chl. b and carotenoids), protein and amino acid in the leaves of different nodes from apex have been shown in Table 1. The pigment and protein content increased from 2nd to 6th node, maintained a steady state up to 8th node followed by a decline thereafter, suggesting the initiation of senescence whereas the content of amino acid increased from 2nd to 12th node.

TABLE 1 : Changes in the content of pigment, protein and amino acid from leaves of different nodes from apex of sunflower plant. (The data in the table are expressed in mg/gm fresh wt)

Leaves from different nodes	Chl.a	Chl.b	Carote-noid	Protein	Amino acid
2nd	0.912	0.450	0.298	22.97	2.02
4th	1.248	0.602	0.366	32.29	2.41
6th	1.354	0.653	0.385	33.73	2.64
8th	1.351	0.656	0.386	33.61	2.69
10th	1.103	0.568	0.341	24.07	2.84
12th	0.693	0.367	0.246	11.09	3.25

Each point represents the mean of four estimates; SD < 5 % of the mean.

The absorption spectra of isolated chloroplasts from leaves of 2nd (developing), 6th (fully matured) and 12th (senescent) nodes from apex have been shown in Figure 1. The absorption spectra showed a distinct decline at the peak of red bands on chloroplasts isolated from leaves of 2nd and 12th node as compared to the peak value obtained from the chloroplasts isolated from the leaves of 6th node. Figure 2 shows the level of MDA in chloroplasts isolated from fully matured, senescing and senescent leaves. The level gradually increased in the leaves with increasing node number from the apex. The level was minimum in fully matured leaves and maximum in senescent leaves.

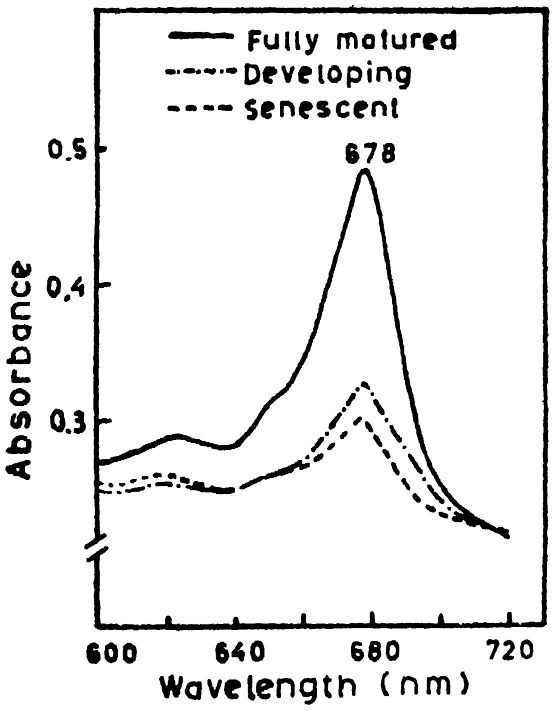

Fig. 1. Absorption spectra of chloroplasts isolated from developing, fully matured and senescent leaves

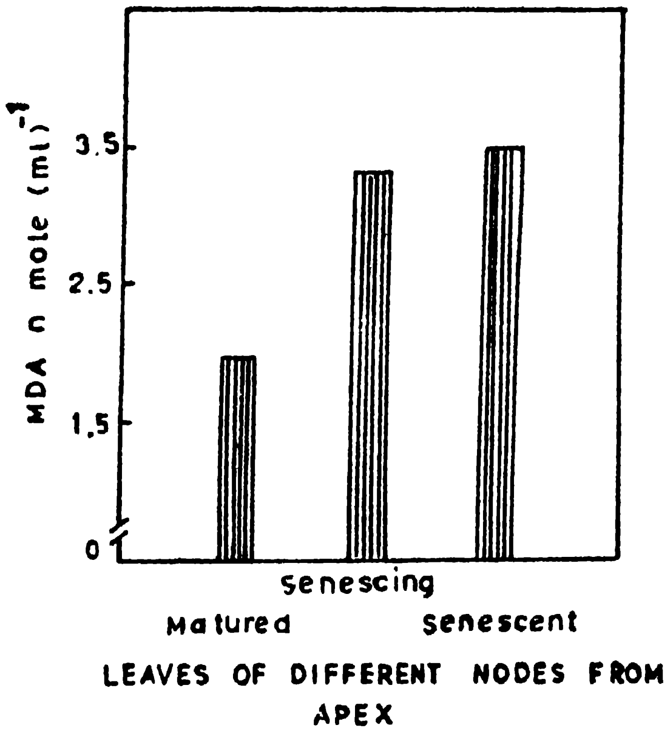

Fig. 2. Changes in the level of MDA in chloroplasts isolated from fully matured, senescing and senescent leaves. Each point repesents the mean of four estimates

The leaves from 2nd and 4th nodes represented the leaves at developing stage, leaves from 6th and 8th nodes were fully matured and the leaves from 10th and 12th nodes represented the stage of senescence as characterised by the pigment and protein content (Table 1). The senescing status of the leaves from 10th and 12th nodes is further confirmed by a relative increase in their amino acid content. The increase in the amino acid content is attributed to senescence-induced protein hydrolysis[11]. The fully developed and matured status is characterised by a steady level of pigment and protein in the leaves at 6th and 8th node. Compared to the peak heights of red absorption band of chloroplasts isolated from the leaves during steady state, a decrease in the peak height (Fig. 1) during development and senescence stages may suggest incomplete development and damage of thylakoid membrane, respectively. The peroxidation of thylakoid lipids in this system is probed by the accumulation of MDA, a product of lipid peroxidation. Thylakoid degradation during ageing of chloroplasts *in vitro* is normally attributed to membrane lipid peroxidation[12]. A relatively high level of MDA accumulation in the chloroplasts isolated from the senescent leaves (Fig. 2) suggest that lipid peroxidation could be a factor for degradation of chloroplasts *in vivo*.

We thank Prof. M. C. Dash, ex-H. O. D. for providing laboratory facilities.

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Studies on the detection of carboxylic acids by using triphenylmethanes—Part II

In continuation of our work[1] on the studies on detection of the carboxylic acids by using various triphenylmethanes in their leuco form and to achieve a goal to establish structural co-relationship with the colour development of the triphenylmethan dyes, it was thought desirable to use Na_2S/dil. acid as well as N_2S/NH_4OH reagent as reducing agent to prepare leuco dyes. The reduction of the triphenylmethanes were carried out in alkaline pH (8.2-9.6). Thus, in the present investigation, Basic Fuchsin (C. I. 42500), Crystal violet (C. I. 42555) and Malachite green (C. I. 42000) were reduced by using Na_2S and dil. H_2SO_4 reagents as the reducing agent (Tables 1 & 2). The method is reported elsewhere[2-4]. Acid Fuchsin (C. I. 42685), Brilliant green (C. I. 42040) and malachite green (C. I. 42000) were reduced by using H_2S gas bubbled in NH_4OH soln. Thus, 200 mg of the dye was dissolved in warm triple-distilled water (100 ml) to which added 5 ml of 1N H_2SO_4 solution and 1.0 gm sodium sulphide (Na_2S). The solution was shaken thoroughly for about 1 min and left at room temperature for about 2 hr; it was filtered through Whatman filter paper (No. 1) to collect colourless to straw yellow filtrate. The pH of the resultant dye reagents varied from 9.3 to 9.45. Similarly, about 250 mg of the dye was dissolved in 90 ml triple-distilled water to which 10 ml (25%) ammonia solution was added. The mixture was shaken thoroughly. At ambient condition of temperature and pressure, the slow stream of H_2S gas was passed through the alkaline solution for about 30 min or till there were persistent smell of H_2S from the mixture. The resultant mixture was left overnight in well-closed stoppered container. It was then filtered through Whatman filter paper (No. 1) to collect light-yellow reagent. The pH of the dye reagents ranged from 8.18 to 9.58.

In a smaller quantity, carboxylic acids were interacted with the dye reagents. As these dye reagents were reacting with alcohols, acetone, chloroform and solvent ether, the solid acid samples were not dissolved in solvents and used directly. In addition to this, in many cases, the colour change was observed after 10-15 min. Hence, we have recorded the colour change in two stages : (a) immediately after mixing an acid of dye reagent and (b) after 15 min. Also, some carboxylic acids were not miscible with aqueous solution of the dye reagent and formed two layers. In some cases upper and in some cases lower layers were the reagent layer, depending upon the specific gravity of acids. In such cases, the colour change were recorded for both the upper and lower layers. As many of the carboxylic acids imparted striking deep colouration other than the original hue, it may be concluded that these dye reagents are suitable for the detection of carboxylic acids. As the colour change noted by mixing the dye reagent and various acids (saturated/unsaturated, mono/di and keto/hydroxy carboxylic acids) were somewhat alike, our attempts to establish a link between the structure of carboxylic acids and colour development did not succeed. Thus, it is very difficult to establish structural co-relationship with the development of colour by the interaction of acids of the dye reagent.

The author wishes to record his deep sense of thanks to the General Manager Dr. M. H.

TABLE 1 : Na_2S/dil. acid as reducing agent

		Basic Fuchsin (Pale Yellow) pH = 9.35		Crystal Violet (Colourless) pH = 9.42		Malachite green (Pale Yellow) pH = 9.32	
		After mix.	After 15 min.	After mix.	After 15 min.	After mix.	After 15 min.
Saturated Monocarboxylic acid							
Acetic acid (glacial)		Carmine red	Carmine red	Colourless	Colourless	Bluish green	Bluish green
Propionic acid		Carmine red	Carmine red	Pale lilac	light blue	Bluish green	Bluish green
n-Butyric acid		Carmine red	Carmine red	Colourless	Pale blue	Bluish green	Bluish green
n-Voleric acid	U.L.	Deep pink	Deep pink	Colourless	Light-blue	Bluish green	Bluish green
	L.L.	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless
n-Capric acid	U.L.	Crimson red	Crimson red	Colourless	Light-blue	Pale green	Bluish green
	L.L.	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless
Saturated Dicarboxylic acid							
Oxalic acid		Colourless	Colourless	Milky	Milky	Colourless	Colourless
Malonic acid		Lilac	Lilac	Milky	Milky	Pale blue	Pale blue
Succinic acid		Crimson red	Crimson red	Milky	Pale blue	Milky	Light bluish green
Gluteric acid		Crimson red	Crimson red	Colourless	Colourless	Milky	Pale bluish green
Adipic acid		Crimson red	Crimson red	Milky	Pale blue	Milky	Pale bluish green
Unsaturated Monocarboxylic acids							
Acrylic acid		Crimson red	Crimson red	Colourless	Colourless	Bluish green	Bluish green
Methacrylic acid		Crimson red	Crimson red	Colourless	Light purple	Bluish green	Bluish green
Senecioic acid		Light pink	Deep pink	Light blue	Light purple	Pale green	Green
Keto monocarboxylic acid							
Lerulinic acid		Crimson red	Hazzy Crimson red	Light blue	Purple	Light green	Bluish green
Hydroxy Monocarboxylic acids							
Glycolic acid		Hazzy Crimson red	Hazzy Lilac	Milky	Milky	Pale green	Green
DL-Lactic acid		Hazzy Light pink	Hazzy Carmine red	Pale Violet	Light blue	Pale green	Bluish green
DL-2-Hydroxy butanoic acid (Na-salt)		Pale pink	Light pink	Colourless	Colourless	—	
DL-3 Hydroxy butanoic acid (Na-salt)		Pale pink	Pale pink	Colourless	Colourless	--	—
4-Hydroxy butanoic acid (Na-salt)		Light pink	Colourless	Colourless	Colourless	—	—

TABLE 2 : H_2S/NH_4OH as reducing agent

		Acid Fuchsin Yellow pH = 3.18		Brilliant green Pale Yellow pH = 9.27		Malachite green Pale Yellow pH = 9.58	
		After mix.	After 15 min.	After mix	After 15 min.	After mix.	After 15 min.
Saturated Monocarboxylic acids							
Acetic acid (glacial)		Carmine red	Carmine red	Colourless	Light green	Pale blue	Pale bluish green
Propionic acid		Carmine red	Carmine red	Pale green	L. bluish green	L. bluish green	L. bluish green
n-Butyric acid		Crimson red	Crimson red	Pale green	Light-bluish green	Bluish green	Bluish green
n-Valeric acid	U.L.	Colourless	Colourless	Colourless	Bluish green	Blue	Blue
	L.L.	Light pink	Pink	Colourless	Colourless	Colourless	Colourless
n-Caproic acid	U.L.	Colourless	Colourless	Bluish green	Bluish green	Blue	Blue
	L.L.	Light pink	Pink	Colourless	Colourless	Colourless	Colourless
Saturated Dicarboxyl acids							
Oxalic acid		Light pink	Deep pink	Hazzy white	Hazzy white	Pale green	Pale green
Malonic acid		Pink	Carmine red	Hazzy white	Hazzy white	Pale green	Pale green
Succinic acid		Light pink	Pink	Hazzy white	Pale green	Pale green	Pale green
Glutaric acid		Yellow	Orange	Hazzy white	Pale yellow	Pale green	Pale green
Adipic acid		Light-pink	Pink	Hazzy white	Pale yellow	Yellow	Yellow
Unsaturated Monocarboxylic acids							
Acrylic acid		Carmine red	Carmine red	Colourless	Light-bluish green	Yellow	Yellow
Methacrylic acid		Crimson red	Crimson red	Pale green	Li. bluish green	Light-green	Light-green
Senecioic acid		Pale Orange	Light Orange	Yellow	Yellow	Yellow	Yellow
Keto-Monocarboxylic acids							
Levulinic acid		Yellow	Light Orange	Milky	Milky	Milky	Milky
Hydroxy-monocarboxylic acids							
Glycolic acid		Yellow	Yellow	Milky	Milky	Milky	Pale green
DL-Lactic acid		Crimson red	Crimson red	Milky	Milky	Milky	Green
L-Lactic acid		Carmine red	Carmine red	Milky	Milky	Milky	Green
DL-2 Hydroxy Butanoic acid		Light-Orange	Orange	Yellow	Yellow	Yellow	Yellow
DL-3-Hydroxy Butanoic acid		Light-Orange	Orange	Yellow	Yellow	Yellow	Yellow
4-Hydroxy Butanoic acid		Light-Orange	Orange	Yellow	Yellow	Yellow	Yellow

Mehta, and to Supdt. (Process Research) Dr. M. A. Siddiqui for their keen interest in the work. Thanks are due to GSFC Management for the providing working facilities.

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Received : 17 June, 1988
Revised : 16 August, 1988.

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Exploration of certain insecticidal plants of Uttarakhand hills

The role of insecticides or synthetic insect-repellents in the emergence of green revolution and thereby in meeting the ever-increasing demands for food and fibre due to rising demographic pressures the world over is incontestable. However, a plethora of drawbacks, disadvantages, undesirable side-effects and hazards, stemming from indiscriminate and extensive application of conventional insecticides have surfaced in recent years[1-3]. Pure compounds such as camphene, carvacrol, carvone, cineole, citral, citronellol, eugenol, farnesol, geraniol, d-limonene, L-limonene, linalool, β-phellandrene and α-pinene have been reported to possess lethal action against house flies and other house insects[4].

Certain Himalayan plants are rich source of these compounds but scanty information is available. On the basis of folklore information and literature survey, several plants are available which may be used for insect control. In the present study a few such plants have been collected, identified and their insecticidal values were assessed.

(1) *Artimisia vulgaris*

Locally, it is known as 'Pati' and shrubs are abundantly available throughout the Uttarkhand region of U. P. hills. Steam-distillation of the aerial part of the shrub yielded an essential oil (0.30-0.45%). A physico-chemical analysis of the essential oil revealed : specific gravity, 0.905 ; refractive index $(\mu)_{20}$, 0.68925 ; boiling range (under normal pressure), 80-175°C ; acid value, 2.57 ; solubility in 7-8 vol. of 90% ethanol. An alcoholic extract of the essential oil (0.5-1%) was found to have mortality action against fleas and ticks. In earlier reports[5], oil of the plant has been reported as good larvicide and feeble insecticide. Roots may be used as tonic and antispasmodic. An infusion of leaves and flowering tops is administered in nervous and spasmodic affections in asthma and diseases of brain.

(2) *Chenopodium ambrosioides*

Locally, it is known as 'Upania Jhar'. It is abundantly available in the Uttarakhand hills of U. P. Steam-distillation of the aerial part of plant yielded an essential oil (0.4-0.5%). The yield of oil varies with the stage of plant, maximum yield (0.6%) being obtained during flowering. A physico-chemical analysis of oil revealed : specific gravity, 0.9052 ; refractive index $(\mu)_{20}$, 0.6873 acid value, 2.68 ; solubility in 0.5-1 vol. of ethanol. Essential oil either impregnated with inert material like calcium carbonate, Fuller's earth or petrolium jelly was found to have flea-repellent property. Medicinal value of plant have been reported earlier[5]. The oil is good against hookworm infections. All parts of the plant specially the roots contain saponin. Oil contains ascaridol.

(3) *Heracileum canescence*

The plant is abundantly available in Binsar (Almora) and in some places of Nainital. Leaves of the plant resemble carrot. The plant is deep rooted. The aerial part of the plant, on steam-distillation, yielded an essential oil having a strong-repelling odour. The yield of oil was recorded as 0.3-0.4%. The oil may be used as an insecticide. Field trials are under progress.

(4) *Boninighasiane albiflora*

The plant is abundantly available in the Uttarakhand hills of U. P. The leaves of the plant resemble fenugreek. Steam-distillation of the aerial part of the plant yielded an essential (0.4-0.5%) having a strong-repelling odour. The oil impregnated with inert material like fuller's earth or calcium carbonate was found to have flea-repellent property.

(5) *Nicotiana tabacum*

Wild varieties of tabacco plant are abundant in the Uttarakhand hills of U. P. The plant has been reported to have insecticidal properties. The medicinal value of plant leaves has been reported as sedative, narcotic, emetic, antispasmodic, used in rheumatic swelling, skin disease, for scorpion sting and as fish poison. The leaves of the plant contain glucoside and isoquercitin. The principal alkaloid is nicotine, other in lesser amount is nornicotine[5].

(6) *Canabis sativa*

It is abundantly available in the Uttarakhand hills of U. P. The plant is locally named as 'Bhang'. The plant is used as a flea-repellent according to folklore information. Steam-distillation of the aerial part of the plant yielded a dark-red coloured essential oil (0.1-0.15%). Leaves contain 1.5% terpene, 1.75% sesquiterpenes and little quantities of paraffin hydrocarbons and 33% of crude red oil. The medicinal values of the plant have been reported as tonic, intoxicant, stomachic, antispasmodic, analgesic, narcotic, sedative and anodyne[5].

(7) *Ocimum americanum & O. sanctum*

Ocimum americanum is available in the lower hills of Uttarakhand. *O. sanctum* is very much popular among Hindus of Uttarakhand. Steam-distillation of the leaves yielded an essential (0.2-0.3%). It has been reported that *O. americanum* contains 16-25% true camphor. An oil from mature plants contain citronella 15.7%, L-linalool 10.25%, methyl cinnamate, citronelic acid and eugenol. Leaves made into paste are used in parasitical skin disease and applied to the finger and toenails during fever.

(8) *Thymus seripyllum*

The plant is abundantly found in high altitudes of Uttarakhand, viz. Harsil (Uttarkashi), Jageshwar (Almora), Binsar (Almora) and Doonagiri (Almora). Steam-distillation of the aerial part of the plant yielded an essential oil (0.3-0.6%), a physico-chemical analysis of the oil revealed : specific gravity, 0.909 ; acid value, 1.68 ; $(\mu)_{20}$, 0.68935 ; soluble in 1-2 vol. of ethanol. An essential oil of the plant may be applied in toothache and thus acts as a strong germicide. It has medicinal value, given in weak vision, complaints of stomach and liver, suppression of urine and menstruation[5].

In addition to above, a good number of aromatic plants have been collected and are under study. A systematic screening of such plants shall certainly be useful for the development of natural insecticides/germicides as an alternative means to replace synthetic hazardous insecticides and medicines.

Authors are thankful to Shri M. C. Joshi, Director, DARL, Almora for encouragement and thanks are also due to Dr. P. C. Pande, Asstt. Professor (Botany), Kumaon University Campus, Almora for the help rendered in the identification of plants.

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Received: 17 June, 1988
Revised: 23 December, 1988.

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Pectin content in some minor fruits and fruit parts

In the fruit preservation industry, guava, apple, strawberry, plum, pear, berries, pineapple, etc., which are fairly rich sources of pectin, are commonly used in the manufacture of edible jellies and jams. The cost of production and consequently, the selling price of these products usually go up by the use of such fruits as they fetch higher prices in the market for their demand by consumers as table fruits. A number of workers[1-2, 6-9] have reported appreciable amount of pectin in unconsumable parts of some agricultural and horticultural commodities, viz., peels of mango, citrus, husk of cocoa pods and kola nuts, skin and core of jackfruit, peel of onion etc. In the present study, some minor fruits which grow in West Bengal—carambola (*Averrhoa carambola*), olive (*Elaeocarpus serratus*), tamarind (*Tamarindus indica*), water-chestnut (*Trapa bispinosa*), shaddock (*Citrus grandis*), lemon(*Citrus limon*), jamir lemon (*Citrus jambhiri*), wood apple (*Aegle marmelos*) were used in fully mature stages and the pectin content in their pulp or husk was determined.

For determining the pectin content[5], 250 gm of finely pieced representative sample was pulped and boiled with about 500 ml of distilled water for 3 hr. After cooling, the slurry was filtered (Whatman No. 1 filter paper) and the filtrate was made up to 1,000 ml with the same water. To 100 ml of filtrate, equal volume of 95% alcohol was added ; it was stirred well and maintained at low temperature for 1 hr. The precipitate was filtered through previously weighed filter paper (Whatman No. 1), after which the filter paper containing the precipitate was dried (60°-65°C) to determine the dry weight of the precipitate alone and the pectin content was represented as percentage of fruit samples used. For each fruit or its parts tested, 4-5 replications were followed and the average values have been presented in Table 1.

TABLE 1 : Pectin content in fruits and fruit parts studied

Name of fruits	Parts used	Percentage of pectin on the fr. wt. basis of fruits (Average of all replications)
Carambola	Pulp (without seeds)	4.00
Olive	,,	2.57
Tamarind	,,	1.27
Water-chestnut	Seed	0.58
Shaddock	Inner peel (albedo)	3.50
Lemon	,,	3.11
Lemon	Segments with juice sacs, rags and core	1.06
Jamir Lemon	Inner peel (albedo) with segments, rags and core	3.80
Wood apple	Pulp (without seeds)	2.66

It is apparent that some of the above fruits or fruit parts may provide suitable raw material for commercial extraction of pectin. Among the different fruits or fruit-parts tested in the present study, pulp of carambola and inner peel (albedo) of jamir lemon, shaddock and lemon could be graded as rich source of jelly-grade pectin, wood apple and olive as fair sources while the rest as of poor source of pectin. In making jam, jelly, etc., the bitter principle present in the peel of citrus, however, needs removal, particularly for the Indian market. Further study on the exploration of jelly-grade pectin and pectic compounds for use in commercial scale from waste by-products and unutilized parts of fruits and other crop plants and their possible improvements by chemical regulatory measures are in progress by the authors

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Received : 17 June, 1988.
Revised : 16 August, 1988.

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Development of *Illeis cincta* on mulberry powdery mildew *Phyllactinia corylea* infesting *Morus alba*

Many microorganisms infect the mulberry causing diseases and making the leaves either nutritionally poor or totally unfit for feeding the silkworm *Bombyx mori* Linnaeus. Powdery mildew, caused by *Phyllactinia corylea* (Pres.) karst. is one such fungus that is very common and widespread in India[6]. Speedy development of the disease as well as maximum incidence was noticed when the relative humidity and temperature were low[4].

Illeis cincta have been reported as predators on mites, aphids and coccids[7,1] and as fungus feeders[2,3]. In fungivorous beetles, the fungus form an essential requirement for their development[3].

Owing to the serious nature of the powdery mildew disease on mulberry from October till January, many control measures have been suggested. However, non-chemical methods are most useful in the mulberry crop system. The coccinellid beetle *Illeis cincta* Fabricious both in adult and grub stages were found actively feeding on the fungus (powdery mildew) intesting mulberry leaves. An attempt was made to know the fungivorous efficiency of the beetle and its development. The biology of the beetle on the fungus (powdery mildew) was undertaken in the Department of Entomology, College of Agriculture, Dharwad under the room-temperature of 17.95±1.57 to 35.24±1.23°C and relative humidity of 79.45±4.43 per cent.

Field collected, sexed adults of *I. cincta* were enclosed in cages of 80×40×30 cm. On powdery mildew infested mulberry leaves for egg laying. Eggs laid on each day were maintained individually in petri cages of 12×3 cm for hatching. The grubs, soon after hatching were provided with mulberry leaves naturally infested by powdery mildew. The petiole of the leaf was wrapped with wet cotton to maintain the succulency of the leaf. Four replications were maintained with two grubs in each petri cage. Fresh powdery mildew infested mulberry leaves were provided daily till the larvae pupated. Data on the developmental duration and fecundity were recorded.

Freshly laid eggs were creamy white, smooth with a flat base, measuring 1.00 mm long and 0.5 mm broad. They turn to dull white before hatching The eggs hatch during cool hours with an incubation period of 3.00±0.22 days.

The grub underwent three moults, occupying 9.64±0.51 days. The first, second, third and fourth instars occupied 2.00±0.00, 2.00±0.00, 2.06±0.01 and 3.58±0.15 days respectively. The newly hatched grub was 1.1 mm long and 0.4 mm broad with slight yellow colour. Second and third instars were similar to the first, except for their gradual increase in size. Fourth instar grub had yellow dorsal and white ventral surface. The thoracic and abdominal segments except the first and last show four black spots arranged in row. The grown up larvae measured 6.7±2.5 mm and pupated on the under surface of the leaves.

The pupae were yellowish white, excrate type with a pupal period of 4.37±0.77 days (Table 1).

TABLE 1 : Development of *I. cincta* on *P. corylea*

Stage of development	Duration (days)
Egg	3.00 ± 0.22
Larva/Grub	
First instar	2.00 ± 0.00
Second instar	2.00 ± 0.00
Third instar	2.06 ± 0.01
Fourth instar	3.58 ± 0.15
Total larval period	9.64 ± 0.51
Pupa	4.37 ± 0.77
Adult longevity with food	14.14 ± 0.26
Adult longevity without food	6.00 ± 0.00
Fecundity (Number)	23.00 ± 17.21
Total develomental period	31.46 ± 1.68

Adult, soon after emergence was whitish, turned to yellowish white. The beetles fed on fungus lived significantly for longer period ($X^2 = 4.57$, $P < 0.05$) over the adults which were deprived of food (Table 1). The fecundity, on an average was 23.00±17.21 eggs per female. The life cycle was completed in 31.46±1.68 days. However, Kunovski[5] noticed the immature stages occupying 35 to 40 days.

Authors are grateful to the authorities of Common Wealth Institute of Entomology, London, for identifying the insect.

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Received : 12 August, 1988.
Revised : 5 December, 1988.

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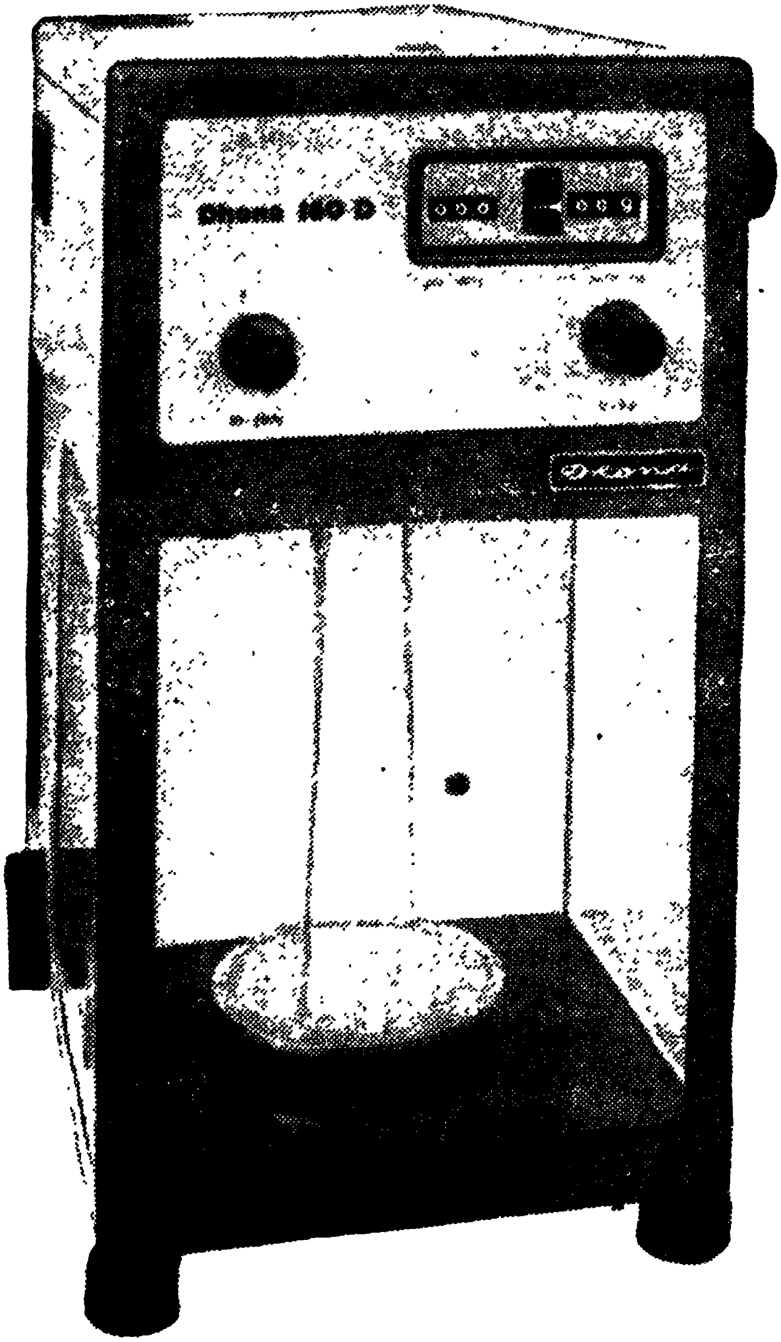

Published and Printed by Santimay Chatterjee, on behalf of the Indian Science News Association,
92, Acharya P. C. Road, Calcutta-700 009 at B. G. ART PRINTERS ★ CALCUTTA-700 054.

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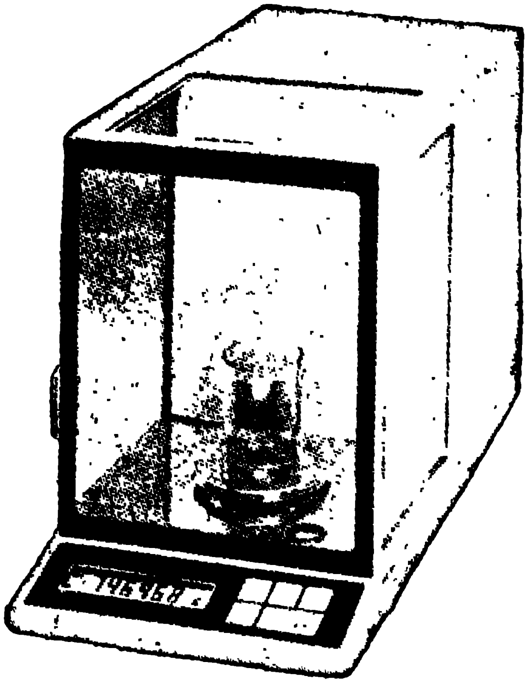

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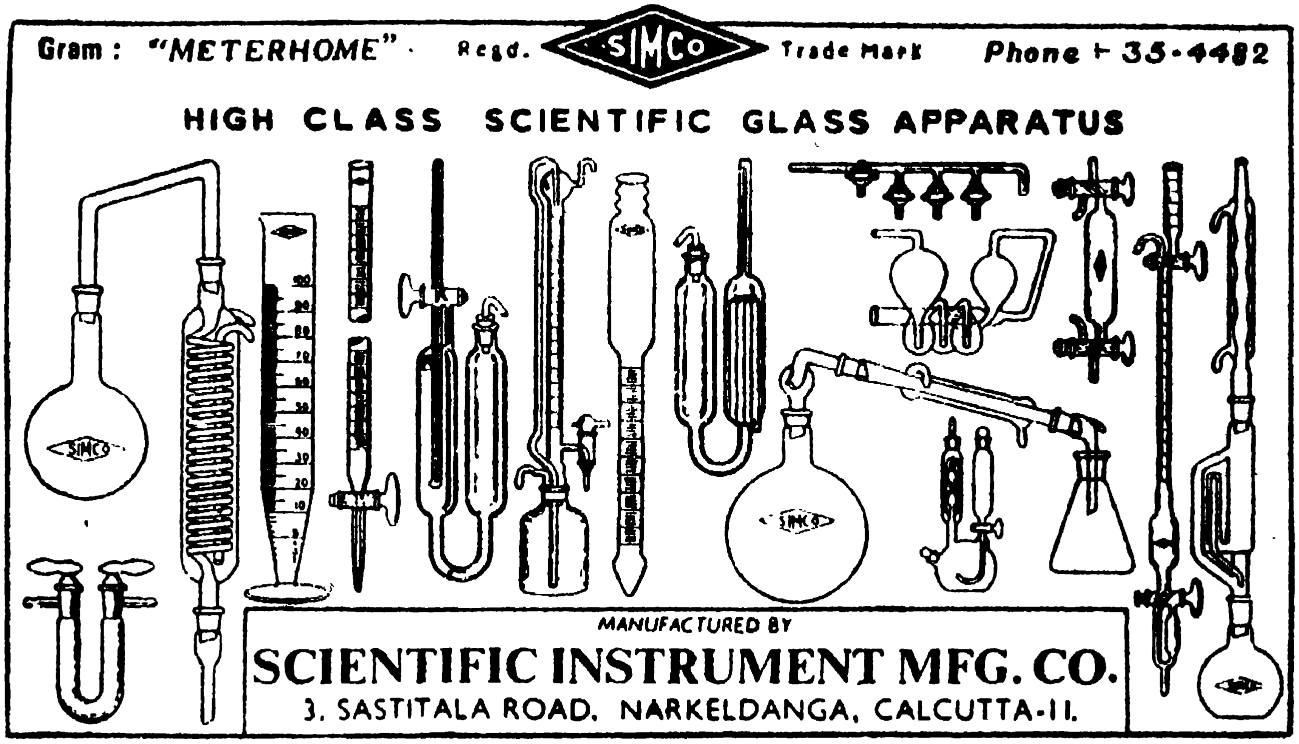

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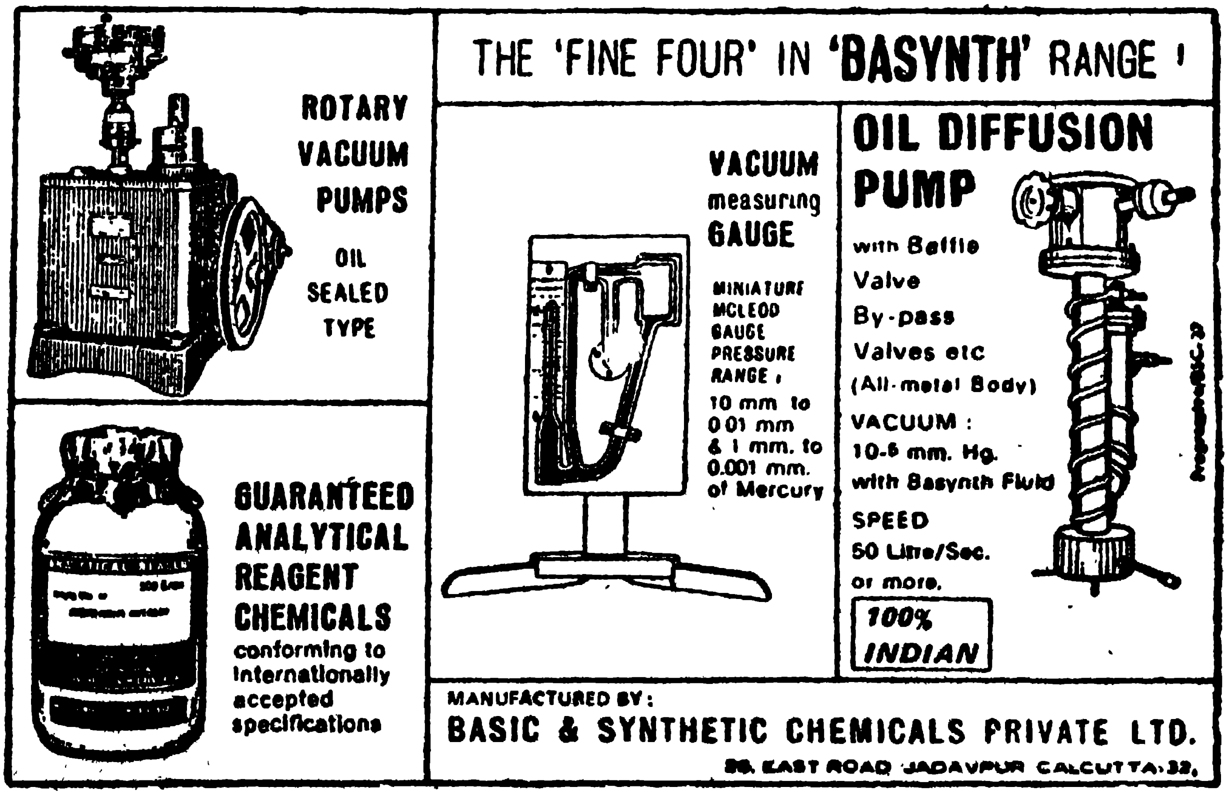

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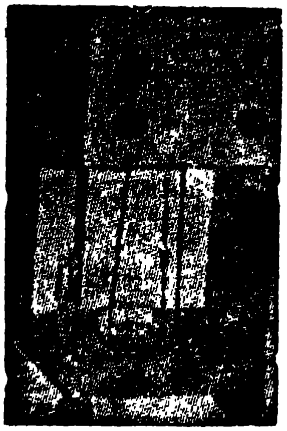

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NEW DIRECTIONS IN SPACE PROGRAMME

ROCKETS, deep space probes and man-made satellites have ushered in a new era of scientific research and technological achievements—in space, from space and also about space. The epoch commenced on October 4, 1957 when the Russian satellite SPUTNIK I was first successfully put in orbit round the earth. Russian success was followed by the Americans with the successful launching of EXPLARER I on January 31, 1958. The progress made in the exploration and exploitation of space science and technology in the last thirty years have been phenomenal.

On the exploration side,—man had been to the moon, collected and brought back samples of the lunar soil for detailed analysis. Our knowledge about the moon has been enriched. Continuous data radioed back to earth from the different *space probes* flying past the distant planets have increased our knowledge about the planetary atmospheres and also about their natural satellites. The so-called orbiting '*astronomical observatories*' equipped with different types of sensors are unravelling the mysteries of the universe in general and of the Sun in particular.

So far as the 'exploitation' aspect is concerned, the different space application technologies have been proved to be of immense benefit to mankind. Modern "*Weather Satellites*' aid greatly in fairly accurate weather prediction. '*Communication satellites*' of different nations including our INSAT IB have established a global communication network. Telecommunication channels have been enlarged and the global television coverages have been expanded through international cooperation. Efficient earth resource surveys are being made with different sensors on board the '*remote sensing satellites*'.

Scientific research and subsequent technological developments never remain static. In the present 'Space Age', new directions in space programmes are being envisaged. Based on the experience of the present achievements, bigger projects are being planned for further exploration and exploitation of space. A new Industrial revolution—one that will be established in orbit, is being envisaged. Progress has already been made in the design and development of much more efficient and powerful launching rockets. Industrialization of space ; establishment of a permanent lunar base ; landing of man on our neighbouring planet like Mars ; giant solar power satellites ; possible modification of Martian and Venusian atmospheres ; gigantic space ships for future colonization of space are some of the programmes for the future, much talked about.

Experiments conducted in the manned space stations, such as the Soviet 'Salyut' and the Euro American 'Spacelab', utilized the weightless condition of space to produce new materials such as special types af alloys ; crystals of new semiconductor materials and super-pure vaccines. Special in the sense that these are unobtainable on earth. It is believed that these new products and processes will be of immense benefit to mankind. Eventually such industries will be housed in spacious space laboratories and of the future, being planned. These may also serve as the processing centres in which metals will be extracted from the rocks of moon and of asteroids believed to be rich in minerals. Besides the proposed space Colonies, permanent lunar bases may also be established for the future industrialization of space. Experiences of the American astronauts and also of the Soviet Cosmonauts have proved that man can stay and successfully work in a space ship for a prolonged period of time. It is thus expected that by the turn of the present century, a 'new Industrial revolution will evolve in space for the ultimate benefit of mankind.

Another major aspect of 'Space Industrialization' may perhaps be the use of giant satellites designed to beam solar energy to the earth. Colossal solar panels on board these satellites will receive solar energy, continuously converting it to microwaves. Received by the specially designed stations these will eventually be converted into normal electric power for distribution. Who knows that by the middle of the next century acute global energy crisis may be solved !

'Colonization of space' has been much talked about in recent times. Besides the plans for possible modification of the Martian atmosphere, designs and blue prints of gigantic man-made colonies in space for housing thousand of people are being published frequently in popular science journals. Whatever may be the speculations of the futurologists and of the science fiction writers, our past experience over the last three decades would perhaps make us optimistic.

Apprehension of the future 'militarization of space' by the super powers can not be completely ruled out. Powerful rockets and modern destructive weapons are being developed under the umbrella of defence. Any future world war will be enough for the complete annihilation of mankind. International space law, peace and treaty forums have already been deeply concerned about the impending danger. Let us only hope that the ethical and religious consciousness of the authorities concerned be aroused not for destruction but for the ultimate welfare of mankind ! □

M. K. Das Gupta

TRENDS OF RESEARCH IN BIOACTIVE SUBSTANCES*

S C. PAKRASHI**

NATURAL products have fascinated the organic chemists more often than not because of intriguing structural complexities apart from their usefulness as drugs, pharmaceuticals and other industrial chemicals like oils, resins, tannins, saponins, rubber, gums, waxes, dyes etc.

Plant products are usually divided into two categories : primary and secondary metabolites. While the importance of the primary metabolites as food or food additives or other industrial raw materials like cellulose and fatty acids cannot be underestimated, the secondary metabolites having no apparent role in the primary metabolic process of the plant have interestingly attracted greater attention of the chemists and biologists alike. It is to these secondary metabolites that we shall address ourselves. The highlights of the recent advances in the following chosen areas viz. (i) drugs, (ii) marine products, (iii) allelochemicals and related products, viz. pesticides (iv) plant pigments and the phenomenon of colour, (v) leukotrienes and related substances involved in mammalian physiology, and in the techniques like (vi) microbial transformation, (vii) tissue culture and (viii) organic synthesis are likely to reflect the scope of research in these areas in the near future.

(i) Drugs

Search for biologically important compounds and discovery of new drugs have been the most fascinating pursuits of research on natural products. Besides the vitamins, hormones and antibiotics, the drugs of natural origin include several alkaloids like emetine, ephedrine, quinine, reserpine, vinblastine etc.

Among the more recent important drugs from plant source, mention may be made of 'Qinghaosu' or 'artemisinin', the antimalarial isolated (1) from the Chinese plant *Artemisia annua*. It is a sesquiterpene endoperoxide strikingly different from all other known antimalarials and is particularly effective in the treatment of cerebral malaria. Some of its derivatives appear to be still more potent. Mention may also be made of the two plant derived drugs, viz. Etoposide (anti-neoplastic) and Atracurium besylate (skeletal muscle relaxant) which received approval in USA as late as 1983.[2]

This aspect of natural product chemistry will always remain important and of particular relevance to the developing countries with their rich flora and fauna. Ironically, while the more advanced western countries have started to rediscover the benefits of herbal remedies, the policy planners and even scientists of many developing countries are yet to be convinced and hardly seem to realise that the prototypes of all the synthetic drugs save the sulphur based ones are of plant origin. Development of pethidine by structural modification of morphine, the well-known analgesic, to eliminate some of its side effects is an example on the point. The importance of the natural products could also be appreciated from the simple facts that atleast a quarter of all prescriptions in USA worth well over a billion dollars alone are still compounds of natural origin and that the potential market for which natural products are being developed

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*Lecture delivered at the 53rd Annual General Meeting of Indian Science News Association held on 31. 3. 89.

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again in USA now are a staggering US $ 400 million for anti-cancer drugs, $ 192 million for antifungals, $ 27 million for cardiovascular drugs and $ 24 million for antivirals[3].

Another emerging area which appears to hold promise is the search for other types of therapeutic agents, eg. tranquilizers, muscle relaxants, antiarrythmics and antihypertensives in fermentation broths so far investigated only for antibiotics and related products like antifungal, antiparasitic or antiviral agents[4]. Thus, Japanese workers have succeeded in isolating an enzyme inhibitor which exerts antihypertensive activity in animals possibly by inhibition of catecholamine biosynthesis. Enzyme inhibitors like folate antagonists are highly useful in the treatment of various diseases including cancer and malaria. Advances in the knowledge of the active site of enzyme has now opened up new possibilities for drug development along these lines too[4].

One other field of interest lies in the biologically important peptides like endorphins and enkephalins. However, one major problem has been their short half-life because of their susceptibility to enzymic degradation. It is possible, however, that a study of their structure-activity relationship would lead in future to smaller non-peptide equivalents without this drawback[4].

(ii) Marine products

For a long time, natural drugs came from the terrestrial sources. Recently, however, chemists have ventured into that fathomless mystery called 'Ocean'. Indeed, spectacular growth has been witnessed during the last two decades in the chemistry of marine natural products. Because of their exposure to high salinity, marine flora, fauna and microbes elaborate varieties of compounds often with unique biological properties and novel structures apparently through biogenetic pathways quite distinct from those of their terrestrial counterparts. Thus, the sesterterpenoid monoalide from a sponge (*Luffariella variabilis*) has been found to have good analgesic properties but its unique structure is unrelated to the known analgesics like morphine, salicylates etc. Sponges have also been found to be the most abundant source of unusual sterols. For example, twenty four sterols out of seventy four encountered in *Axinella cannabina* turned out to be novel[5]. Gorgosterol found in filter feeding soft corals and in marine invertebrates contain an unusual cyclopropane moiety. Micro algae, the components of aquatic and phytoplankton produce a diverse variety of biologically active compounds such as toxins, plant growth regulators, steroids, sulphated polysaccharides and antibacterials etc.

Mention may also be made[6] of the toxins like tetrodotoxin and saxitoxin or of kainic acid and the cephalosporin antibiotics. Okadaic acid, recently isolated and characterised, also possesses unique pharmacological activities. A new and highly effective insecticide (cartap hydrochloride), which is essentially non-toxic to warm-blooded animals and is biodegradable, has been developed in Japan based on studies using nereistoxin, a potent neurotoxic agent obtained from a marine worm. The recently isolated bryostatins[7] having significant antineoplastic activity have already entered the final clinical trial phase. Cephalostatin I isolated from a marine worm has significant cell growth inhibitory effect[8]. Marine organisms like blue-green algae could yield potentially marketable products, eg. β-carotene and other flavour enhancing pigments, polyunsaturated lipids useful in lowering blood cholesterol etc. Algae mariculture through genetic engineering appear to be a technical feasibility for the production of industrial phycocolloids such as agar for which no synthetic substitute is available and the cost is ever increasing[9].

The sea, specifically the coral *Plexaura homomalla* also provided the first important natural source of analogues of prostaglandins, which are expected to be as important in medications as penicillin or the steroids. The isolation of PGE_2 and PGF_2 from the Australian red alga *Gracilaria lichenoides* was in fact the first reported[10] occurrence of prostaglandins in a plant. Sea-weeds are thus an important source of pharmaceutical products which our country has yet to exploit fully.

Mangrove forests and swamps constitute a specialised class of ecosystem of considerable economic importance. A study on the flora and fauna of this particular system is important[11].

The impact of advances in separation processes designed to purify air or water sensitive constituents or the highly polar water soluble ones and in spectroscopic and synthetic techniques for structure establishment may be exemplified by two marine products : palytoxin and tunichromes. Palytoxin, a highly toxic metabolite from algae, has an extraordinarily large molecule ($C_{129}H_{223}N_3O_{54}$) without repeating sub-units like amino-acids and sugars and has 64 asymmetric centres and 7 double bonds which permit a huge number of stereoisomers. It is also unstable, non-crystalline and insoluble in organic solvents. Its isolation and structure determination, the latter particularly, because of the conformational mobility, required novel techniques. Spectroscopic studies afforded the planar structure and partial stereochemistry[12] later completed through synthesis[13].

Tunichromes, on the other hand, are blood pigments of the tunicates, common marine organisms that selectively accumulate metals such as V, Fe, Mo, Nb in their blood cells. The first of the highly air and water sensitive tunichromes, tunichrome B-1, has now been obtained pure after 5 years of careful separation processes. Its structure determination, however, proved simple though only 0.5 mg sample was available[14].

The two examples indicate that both improvements in isolation technique and in structural tools for noncrystalline, conformationally mobile molecules remain as present day challenges.

Evidently, investigations on marine products have been advancing rapidly in recent years in search of bioactive substances from sea which constitute the source of about 85% of edible plant mass and 80% of all animals species of the world. Indeed, even for the coming century, a scientific forecast envisages that useful drugs and chemicals will inevitably be discovered from the marine sources, particularly because of the promises held out by the application of biotechnology to chemical processing[15].

(iii) Allelochemicals and related products

Allelochemicals are produced by higher plants to afford them protection from predators, to inhibit growth of rivals, or merely in response to an external stimulus. They may be defensive or offensive in nature. A study of the interaction between plant and its environment has also bearing on the development of new pest management techniques or of new antimicrobial agents.

Among the irritant and defence substances identified from glandular hairs of toxic plants, one may mention the detection of biogenic amines like acetyl choline, histamine and serotonin from **Urtica, Laportea and Jatropha** species.[16]

Many plants produce toxins which afford them protection against insects. A study of plant-insect interaction has led to the identification of the pyrethrin group of insecticides. The discovery followed the observation of heaps of dead insects around the plant *Chrysanthemum cinerariaefolium*. Rotenoids are the other group of pesticide emerging from natural product research. Some of the alkaloids like nicotine also find some use as insecticide, while physostigmine, the alkaloid from calabar bean (*Physostigma venenosum*) served as a model for carbamate insecticides.

A study of the insect chemistry has led to the detection of minute amounts of hormones responsible for the maturation process—the ecdysones and the juvenile hormones. Insect growth regulants are, therefore, being investigated for the control of insect population. Since only four major classes of insecticides-chlorinated hydrocarbons, organophosphates, carbamates and photostable pyrethroids—have been developed in the last 40 years, new insecticides are needed and antifeedants have become important in integrated pest management[17]. Developing new pesticides and herbicides from plant sources may, infact, be even more prospective than drug development.

(iv) Plant pigments and the phenomenon of colour

The phenomenon of colour in plants has been one of the most investigated areas of research. Recently, Goto[18] has suggested that the colour variation of flowers, fruits and autumn leaves are due to various types of stacking of anthocyanidin itself and also between anthocyanidins and flavones. The helical stacking of anthocyanidin diglucosides are stabilized by hydrophobic interaction between their aromatic nuclei and is the cause of colour changes.

(v) Leukotrienes and related substances involved in mammalian physiology

Studies in mammalian physiology has led to the recognition of the newest member of the arachidonic acid derivatives, the leukotrienes, or 'slow reacting substances (SRS)' as they were called earlier, besides the physiologically important prostaglandins and thromboxanes. The leukotrienes were initially isolated in meagre amounts and the correct structure assumed on consideration of whatever data was available coupled with sound chemical consideration could be confirmed synthetically[19]. This also permitted the availability of sufficient material for biological activity testing. Available evidences indicate the crucial role of this group of compounds in hypersensitivity, allergy and inflammation. The development of antagonists of the leukotrienes is also of considerable medical importance and already some progress has been made in this direction.

(vi) Microbial transformation

Soybeans are the sources of steroids which are microbiologically converted to many useful steroid pharmaceuticals or important intermediates in the synthesis of steroid hormones. Plant cell cultures have also been used to convert an exogenous precursor to a desired metabolite. An example is the 12β-hydroxylation of β-methyl digitoxin to β-methyldigoxin by *Digitalis lanata* cells. This process also holds promise for the synthesis of novel compounds not produced by the plants by using appropriate precursors. Immobilised enzymes may be used in future to carry out such biotransformations. Advances in genetic engineering also may offer new possibilities.

(vii) Tissue culture

Though genetically engineered microorganisms may prove to be efficient sources of useful proteins, production of secondary metabolites by this process appears at the moment to face unsourmountable difficulties.

This is primarily because proteins are immediate gene products, while usually several gene products need to act jointly to produce the secondary metabolites. Therefore, plant tissue culture is being seriously considered for industrial production of valuable secondary metabolites, particularly in view of the large scale deforestation which may even obliterate useful plant species. Cell suspension cultures may provide a reliable and continuous source of useful plant products which simultaneously would be easier to purify in absence of sufficient pigments. At the moment, only a restricted number of high value, plant specific products with sufficient market demand, eg. the *Digitalis glycosides* and *Catharanthus alkaloids*, qualify for plant cell culture method of production, and some of them are already being marketed or are in the process of production. It has recently been reported (by Yamada, Kyoto Univ.) that hybridization between *Euphorbia millii* and *Coptis japonica* could produce very high yield of both berberine and anthocyanin.

(viii) Synthetic organic chemistry

One of the major triumphs of organic chemistry has been the successful syntheses of such complex natural products as cholesterol, quinine, reserpine, chlorophyll, prostaglandins, vitamin B_{12}, penicillin, erythromycin—to name a few. The factors responsible for the sustained interest in the total synthesis has been the challenging structures of the target natural compounds and promising biological activity. With the advent of new techniques of isolation, purification and characterization of even nanogram quantities, the chances of ecountering more challenging structures are more bright today than ever before. However, for biologically active compounds it is essential to be able to synthesise the optically pure compounds. It is, therefore, imperative to develop :

(i) Newer synthetic strategies eg. use of natural products such as sugars and amino acids as chiral templates in organic synthesis ;

(ii) New reactions and reagents as well as powerful methodologies for stereoselective or enantioselective synthesis of natural products with multi-chiral centres. The awe-inspiring 'Sharpless oxidation' which is now a common process for getting near 100% asymmetric induction in the epoxidation of allylic hydroxy compounds is one such achievement ;

(iii) Interface with biology with a view to developing biomimetic chemistry such as synthesis of models which mimic various biological functions of proteins, vitamins etc. In this respect the role of mathematical modelling and computer aided designing of synthetic strategies cannot be overemphasized.

We, thus, look forward to more rewarding developments in the field of natural products in years to come. ☐

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ENVIRONMENTAL CONDITION WITH REFERENCE TO AIR POLLUTION IN THE METROPOLIS OF CALCUTTA*

S. C. DATTA**

"CITY starved of oxygen", "Is Calcutta becoming a gas chamber" and City heading for disaster". These are some of the headlines in newspapers which speak volumes for the environmental condition of the chaotic cosmos known as Calcutta. Coupled with these headlines are tourism's old cliche—"Don't breathe the air" and "don't drink the water". Alarm bells have been sounded and the metropolis is galloping towards an ecological disaster.

Since the early '70s, the National Environmental Engineering Research Institute (NEERI), Nagpur, has been monitoring ambient air for its own studies and for WHO's Global Environmental Monitoring System (GEMS). For a long time, Calcutta was the only Indian city in this 14-country programme. Bombay was added in 1978 and Delhi in 1987.

The NEERI survey has revealed frightful findings in the twin cities of Calcutta and Howrah. Every day, about 1,305 tonnes of emissions are released into the atmosphere. Of the total amount of pollutants, approximately 900 tonnes are generated in Calcutta and the remainder in Howrah. Roughly 44% (560 tonnes) of the pollutants are suspended particulate matter (SPM), 34% (450 tonnes) carbon monoxide, 9% (123 tonnes) sulphur dioxide, 8% (102 tonnes) hydrocarbons and 5% (70 tonnes) oxides of nitrogen. Industries contribute 46% (600 tonnes) of emissions ; this is followed by transport which accounts for 28% (360 tonnes) and thermal plants 15% (195 tonnes).

NEERI's latest published findings (1981) show that in Calcutta the ambient mean of SPM is 418 microgram/cubic metre. In the commercial centre, SPM rose from 365 to 462 microgram/cubic metre during 1973 to 1980. In the worst season and in the worst-hit spots, it can touch a maximum of 3,682 (while the WHO annual mean standard is 90). In absolute terms, the high SPM levels are alarming when their real compositions are examined. In the Calcutta air, a large number (26) polynuclear aromatic hydrocarbons (PACs) are present and many (10) of them are carcinogenic. The most frightening is benz(a)pyrene which rates three pluses on a scale of carcinogenicity. In Calcutta air, the concentration is highest in winter due to temperature inversion : 30.2-120.2 nanogram/cubic metre.

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*Presented at the Seminar on Environmental Studies held at the Maulana Azad College, Calcutta, during December 9-10, 1988.

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SPM constitutes the predominant air pollutant, since about 370 tonnes of dust are daily deposited on the city. A report prepared by the West Bengal Planning Board states that the highest dustfall rate in Calcutta is at Cossipore, where it is 83 tonnes/sq mile/month. The BBD Bag comes next with 77 tonnes, being followed by Manicktala (70 tonnes), Hyde Road (60 tonnes), Tollygunge (55 tonnes), Bhowanipur (49 tonnes) and Sealdah (46 tonnes). However, the dustfall rate is 91 tonnes in Howrah. The digging operations of the Metro Railway as well as CMDA and the overflowing garbage lead to the persistently high level of atmospheric dust.

Calcutta's air has 6.66 microgram of lead/cubic metre in comparison with Berlin's 1.40 during one of its worst pollution episodes. The anti-knocking agent so cavalierly incorporated into petrol is composed of organic-lead compounds, 300-400 times more toxic than inorganic-lead compounds. These are belched out into the air from vehicles, even those in near-perfect condition. By global standards, auto emission contributes 50% of SPM. The bureaucrats who claim that Calcutta has 325,000 vehicles compared to 450,000 in Bombay need to be reminded of their abominable lack of reodworthiness. The pollution quotient of one Calcutta car is equivalent to that of 10 on Western or Japanese roads.

Carbon monoxide, which tends to lower haemoglobin in the blood, is distinctly high, although still below the maximum permissible concentration of 40 ppm. In urban areas, badly maintained vehicles are the chief source. Studies in the USA have indicated that at busy traffic intersections carbon monoxide is found at 50-100 ppm, the equivalent of smoking a pack of cigarettes daily. Cigarette smoke is a major carbon-monoxide hazard even to bystanders. In the case of smokers, this level is raised by an extra 4-5%. With Calcutta's notorious traffic snarls, the hazards are probably twice as high.

At Khardah, a large chemical factory (placed under category A of the hazardous list) was noted to be "not well equipped with facilities to tackle leakage of chlorine which may result in disaster". In the same region, another chemicals (and fertilisers) factory produces sulphuric acid, superphosphate and sodiumsilicafluoride, but Government inspection detected "fumes leaking through the valves in one of the two acid plants" and the analysis of stack gas for sulphur dioxide "was being done (only) intermittenly". All the 25 coconut trees around one of these units have died.

At a chemical factory in Maheshtolla, no effective and pollutic abatement measures exist even though such dangerous materials as sulphuric acid, scrap lead and commercial nitric acid are being handled. At Birlapur, near Batanagar, a factory's pungent gases irritate the eyes of the 3,600 families in the area and affect the 250 patients of the ESI hospital nearby. At Haltu itself, a private undertaking dealing with toxic dyes and oxides has "NIL" marked against Safety Pollution Measures adopted.

The situation is worse than worthless in the Bidhannagar Station area, where 300-odd foundries emit sulphur dioxide from the rectifying of acid with crude methods—in some cases simply boiling in open pans. Thousands of commuters find it hard to breathe and many keep coughing for 8-10 min as local trains enter the railway station. They cover their noses with handkerchieves and heave a sigh of relief once the trains leave the station. Only recently, an aged lady who was ill, fainted inside a compartment and had to be administered first-aid at the Dum Dum junction. Passengers often say : "We shall have a Bhopal here any day". Some local residents allege that they had been facing this problem for a long time. West Bengal's Pollution Control Board had issued notices to 103 of these units, but they have merely expressed their "inability to comply" with the safety measures laid down. Enquiries reveal that virtually nothing can be done to control them, aside from the equally impossible rehabilitation.

All local trains stop at the red signal between Dum Dum and Belgharia railway stations. A dumping ground for nightsoil prevails by the side of the tracks (fourth line). Almost all locals and long distance trains halt 5-10 min here to obtain clearance and some even longer. This waiting is a nightmare for the passengers due to the revolting stench.

As the volume of polluting substances in the air continues to increase menacingly, they deplete the city's quantum of oxygen. It is below normal all over the city and its environs, except in the vicinity of the Botanical Gardens at Sibpur, where it is near normal. The Smoke Nuisance Directorate, Government of West Bengal, has studied the problem and reached the conclusion that the pollution rate is fairly high not only in Calcutta and Howrah, but also in Belur, Bally, Konnagar, Bhadreswar, Chandernagore, Bandel and Barrackpur.

According to environmentalists, oxygen is scarce in the city's atmosphere up to a height of 3½ ft from the ground level and may slump down to nil within the next two decades. Should this happen, it will jeopardise not only the lives of insects and animals, but will usher in serious kinds of ailments other than bronchial disorders among infants and children. Scarce availability of oxygen is thought to be the primary cause for widespread bronchial complaints among the city's infants and children.

The development of Lake Town and Salt Lake as residential areas has affected the city's public health adversely. The city, which once had an average windspeed of about 8 km/hr throughout the year, has currently 1½ km/hr. Environmentalists have calculated that a densely populated city like Calcutta requires at least 6 km/hr for proper percolation of oxygen even to the ground level. Such slow windspeed adds to the city's sultry weather at times.

In recent years, Calcutta Municipal Corporation's Housing Department has raised serious objections against the construction of high-rise buildings in the city. Indeed, these buildings contribute immensely in impairing the city's ecology while the State Government is yet to announce any positive step to check such constructions. These buildings, ecologists feel, impede the flow of wind and retard its speed. The construction of high-rise buildings along the bank of the Hooghly and on every side of the Maidan hinder the flow of wind that emanated from across the river and over the Maidan to the city.

Environmentalists, alongside several senior officials of the Calcutta Municipal Corporation, resent the development of Lake Town and Salt Lake. These areas used to be vast expanses of marshy lands and wet tracts, generating 99,000 litres of oxygen/min. Oxygen thus available catered to the needs of the proximity areas and supplied more than enough for the city. Ever since the development of these as residential areas, the release of oxygen gradually dreclined to a mere 12,000 litres/min at present. Therefore, the development of Lake Town and Salt Lake had been at the expense of the greater interest of the city.

Some time ago, the State Government had planned to develop residential areas similar to those of Lake Town and Salt Lake at Dhapa. But the project was abandoned following stiff opposition from ecologists who argued that the proposed development would interfere with the output of oxygen and its availability in the city. If rigorous controls are not excercised on the future construction of houses along the Eastern Metropolitan Bypass, the problem of oxygen availability to Calcuttans will augment. The civic bodies as well as the State Government should not allow the construction of buildings beyond two stories and prevent the builders from filling up the wetlands.

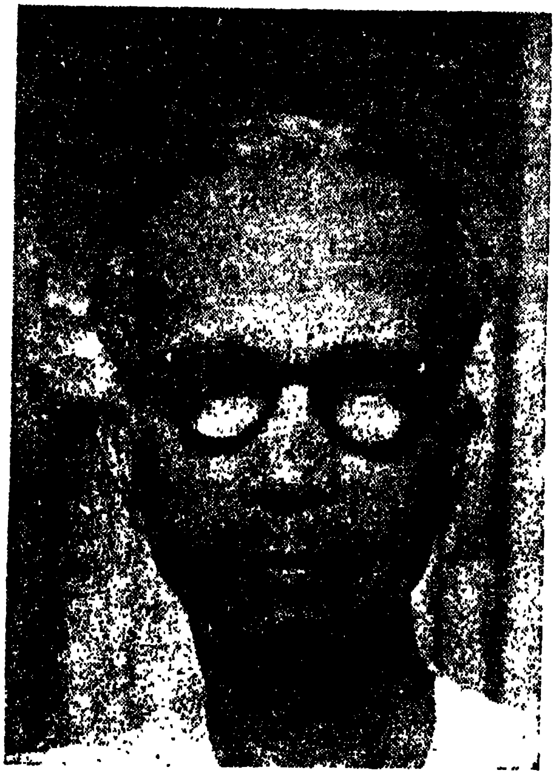
Environmentalists plead for the planting of more trees in and around Calcutta. A green belt is required to minimise air pollution, improve the landscape and maintain the ecological balance. There should be proper planning and periodic checks on the emission of exhausts by fuel-run vehicles. There is general aversion among industrialists to instal reaction-type agglomeration precipitators and other pollution-arresting devices. Industries should set up squads to monitor the pollution level in their respective localities. The stacks of new factories should not be less than 40 m and boilers must be operated by trained staff to evade the so-called smoke nuisance. The consumption of low-grade coal and its substitution by low-temperature carbonised soft coke has been recommended. In every developmental plan of Calcutta and Howrah, the control of air quality is a must.

I end this talk by quoting from an article written by Ms Bachi J. Karkaria in THE STATESMAN during February 28-March 2, 1987 : "Air pollution is a serious matter and cannot be left to lackadaisical officials or bureaucrats luxuriating in a currently fashionable cause. Every lapse adds to that toxic stockpile in the air. Yet the solution is within reach. Unlike water pollution, which involves complex networks of underground drainage systems and deeply ingrained insanitary habits, just a draconian check on auto and industrial emission, could clear the air by 80%. Not to tackle it now would be to press the start button on a slow motion replay of Bhopal". ☐

OBITUARY

BHUPENDRANATH GHOSH
(1900 - 1988)

May 26, 1988, witnessed the sad demise of Professor Bhupendra Nath Ghosh, the doyen of physical chemists in India his at residence, 30, Regent Estate, Calcutta.



Professor Bhupendra Nath Ghosh, D. Sc. (London), F. N. A. son of Ramachandra and Monorama Ghosh was born in Arambag, Hoogly in the State of West Bengal in the year 1900. He had his school education from Raja Rammohan Ray Seminary at Patna. He then joined the Scottish Church College and, later on, the Presidency College, Calcutta from where he passed the B. Sc. examination with first class honours in Chemistry. As a post-graduate student in Chemistry, in the University College of Science, Prof. Ghosh came in contact with Sir P. C. Ray, a scientist who inspired many Indian scholars to scientific research during the renaissance period in the Indian sub-continent. During this period some of Professor Ray's students, namely, Sir J. C. Ghosh, the elder brother of Prof. B. N. Ghosh made a note-worthy contribution to electrolyte theory from the Calcutta University. Prof. J. N. Mukherjee also established a well-known school of colloid science at the Calcutta University. As a student of Professor Mukherjee, Prof. Ghosh became attracted to this particular branch of physical chemistry. In 1924, he passed his M. Sc. examination with thesis in physical chemistry and stood first in order of merit. In 1924, he received Guruprasanna travelling fellowship and joined the University College of London where he started his research with Professor F. G. Donnan. During this period his fields of interest covered colloids, proteins, and enzymes. He received D. Sc. degree from the University of London and returned to India in 1930.

After his return, he became Sir P. C. Ray Fellow of the Calcutta University for sometime and then he served in the Department of Applied Chemistry, Calcutta University, as a lecturer for about thirteen years. He was appointed Reader in the Department of Pure Chemistry in 1947, and subsequently the Palit Professor in 1955 and the Head of the Chemistry Department in 1961. He was elected the Dean of Faculty of Science and Vice President of the Council of the University College of Science, Calcutta University during the tenure of his service. He became a Fellow of the National Institute of Science of India and was twice elected Vice President of the Indian Chemical Society. For a number of years, he was also Honorary Treasurer of the same Society and member of the Council for several terms. He was a member of the Advisory Board of the International Journal 'Toxicon' and a member of the Chemical Research Committee of C. S. I. R., New Delhi for sometime. He was a founder member of the Indian Society for Surface Science and Technology. He retired in the year 1965 but his association with the University continued for several years, as a Retired Professor of Chemistry, under the University Grants Commission.

In the two decades, from 1930 to 1950, Professor B. N. Ghosh carried out extensive research on the biochemical, pharmacological, and toxicological aspects of snake venoms mainly of Indian and Asiatic Origin. In collaboration with his associates including workers from the Department of Physiology, he succeeded in isolating, from cobra-venom, a cardiotoxin and a respiratory toxin which cause failure of heart and respiratory systems and he also isolated some enzymic inhibitors. From 1946 to 1960, Professor Ghosh and his group made elegant studies on the relation between stabilities of colloids and true critical zetapotential. The effect of surface conductance in modifying the zetapotential of the particles was examined and experimentally verified on the basis of original equations derived by Ghosh. These quantitative works have been reviewed extensively by Dukhin and Derjaguin in "Advances in Colloid Science". An original equation for the rate of coagulation of colloids had been proposed by Prof. Ghosh which had later been supported by experiments. His works also embodied critical investigations on the monolayers of soaps adsorbed at interfaces and on the aggregation properties of gelatin and polyacids.

From 1973, Prof. Ghosh continued his theoretical investigations on physicochemical aspects of colloidal electrolytes, proteins, electroviscosities of colloids, etc., in which Donnan effect was introduced for quantitative analysis. On a private visit to England during this period, he delivered several lectures at different institutes on these topics which received high appreciation. For the last few years before his death he concentrated on the theory of strong electrolytes. In fact, he developed equations for the variation of activity, conductance, viscosity and molal volume in terms of cube root of concentration, and substantiated the validity of these equations with the abundantly available experimental data from literature.

As a devoted scientist and a sincere teacher Prof. Ghosh inspired a large number of students by his guidance and discussions and "by example with a devotion to science and contempt of all personal meanness". He was a perfect gentleman and truly, a symbol of simplicity. But, this gentleman was a man of conviction, and never accepted any compromise when it came to the question of principles. He always tried to collect resources for the betterment of facilities for his students but at the same time he would ask his students to make the best use of the available facilities. His students often remember him saying, with reference to his generation of scientists, "We tried to do as much as we could under the prevailing conditions" and asserting that his students should emulate the dedication of their teachers. Prof. Ghosh had strong nationalistic feelings. He believed in elevating the prestige of India in the world. He tried to raise the standard of university education and the status of the Indian Journals by publishing his own research work in these journals. In fact, his last publication appeared in May, 1988 issue of the Journal of the Indian Chemical Society. His total number of publications excedes one hundred fifty.

In 1939, Dr. Ghosh was married to Sati Gupta, daughter of Dr. Nagendramohan and Jyotirmoyee Gupta. Dr. Mrs. Ghosh is herself a great scholar in Bengali literature and she retired as a Professor of Bengali at Calcutta University. She always had and still maintains great affection for all of her husband's students.

In his passing away, the country has lost a dedicated scientist, and his students, a great and affectionate teacher. □

S. Aditya & D. K. Chattoraj

Notes and news

Alcohol from sugarbeet

The Chief Minister of West Bengal recently inaugurated a sugarbeet plant in Sunderban to augment alternative sources to molasses for alcohol production.

Set up with an investment of Rs. 140 lakhs by the Sundarbans Sugarbeet Processing Company Limited (SSPCL), the state government enterprise, the unit will have the installed capacity of about 600,000 litres of industrial alcohol a year. It is estimated that it will be capable of supporting about 200 acres under sugarbeet cultivation.

Apart from sugarcane, sugarbeet is also another viable crop for alcohol production. Being hardy, it is also capable of withstanding mechanical strees, heat, cold, frost as well as drought. Another advantage is that from one tonne of sugarbeet roots, about 85 to 90 litres of alcohol can be obtained and that sugarbeet can be grown even in sodic salts. Production on alkali soils is as good as on normal soils.

For alcohol production, although extra fuel amounting to 13 to 17 per cent by weight of roots will be needed, it has no bar since the extra cost can be met easily by utilization of the leaves and other parts of sugarbeet. The leaves are rich in vitamin A. The pulp, after extraction of sugar, contains 60 per cent carbohydrate and can be used as a good cattle feed. Sugar molasses, being a rich source of citric acid and vitamin B complex, can be employed in pharmaceutical industries to outweigh the loss.

Although sugarbeet can successfully be employed for alcohol production, the source was not tapped in West Bengal previously. The experts meet at Nimpith at Sunderban in 1987 identified the area for extensive production of sugarbeet. They recommended that sugarbeet can be cultivated as the second crop after harvesting of aman paddy. Obviously, it is expected that this would improve the economic lot of the farmers for the region.

However, sugarbeet can be grown almost everywhere in the country. It grows successfully in Rajasthan, Haryana, U. P. etc. Now it will also be grown in the Sunderbans.

The SSPCL's breakthrough in alcohol technology by the use of non-conventional sources including sugarbeet, waste rice, etc. will be a potent means to improve economic condition for the region. Moreover, sugarbeet cultivation will improve quality of the soil by reducing high level of salinity of the soil.

Till now dependence on cane-sugar molasses for alcohol production made molasses as the only raw material. It is hoped that commercial production of alcohol from sugarbeet will be useful in the long run to overcome country's alcohol crisis particularly in the molasses-deficient states.

SSPCL chief executive revealed that the present plant at Nimpith might provide about 6 lakh litres of industrial alcohol per annum as against West Bengal's requirement of about 700 lakh litres. According to him, seven such plants would be set up in the Sunderbans area. ☐

P. C. Bhattacharyya

Science workshop at Saotia, Midnapore

A science workshop for school students and a science exhibition were held during Feb. 17-21, 1989 at the Saotia village organised by Milani Sangha under the auspices of the DST in the programme of the Science and

Technology Application for Rural Development (STARD).

Nearly 50 school students of remote villages residing in the camp day and night participated in the workshop. Fifteen resource persons from IIT Kharagpur, Birla Industrial and Technological Museum, Soil Testing Department of the W. B. Govt. and nearby colleges discussed nearly 30 topics in 30 hours duration of the workshop on the subjects like, environment, energy, computer, history of science, imporved farming, ground water problems, lives and works of Indian scientists specially of C. V. Raman with special reference to the centenary year. Students observed sky every night with two telescopes made by a school teacher, amateur astronomer Sri M. N. Lahiri of the nearby Saori School. All the topics of the workshop were elaborated by slides, films, demonstrations and observations.

The science exhibition consisted of a large number of posters, various models of science, mostly made by the local school students, agriculture implements of the Agriculture Engineering Dept. of the IIT Kharagpur and a personal computer from the Computer Science and Engineering Department of the same Institution, mobile soil testing van of the W. B. Govt., science exhibition van of BITM with a projector and 12 science films, rationalist programmes, film shows by Information and Cultural Div. of the W. B. Govt., anti-war drama staged by the youngsters of the branch of the Agnibina group at Borai.

The workshop and the exhibition were inaugurated by the hon'ble minister Sri Kanai Bhowmik, who stressed the importance of such workshops in rural areas for development of science in the country. Sri B. P. Acharya, President of the Mohanpur Block Anchal Panchayet presided over the meeting. ☐

P. Chanda & D. Maity

Tulips come home to holyland

As city gardeners plant hundreds of thousand of gift tulip bulbs from Holland this fall (1988) in municipal gardens, the popular flower is finding its way back home, the wild tulip has grown for centuries in Israel, the land of its origin. Historians believe that when King Nebuchadnezzar destroyed Jerusalem in 586 BC, royal botanists brought the plant to Babylon where it was domesticated. Although the tulip is not represented in any Western art earlier than the 16th century, it is known that in 1554 the Kaiser in Vienna was sent a case of tulip bulbs from the Turkish Sultan. It was most likely then that the flower received its genus name "turban" or "tulipan" because of its similarity to the Turkish headwear. From Austria, the tulip found its way to Flanders and finally Holland.

Arriving in Israel for the eighth season, the tulip makes full circle in its travels, as the Netherland Friends of Israel send 150,000 bulbs of all colours as a gift to the city and residents of Jerusalem. Besides this symbol of Dutch-Israeli friendship, flower lovers all over Israel independently plant numerous imported tulip bulbs, leaving very few gardens without the bloom in the early spring. ☐

News from Israel

Rare desert bird saved from extinction

In a continuing saga of drama and romance at the Tel Aviv University research zoo, scientists have made a giant step toward saving the Negev lappet-faced vulture. A vulture chick, which was born last spring, is thriving, the only baby of its kind to have been born in captivity. The birth is particularly significant because only one known pair of such vultures is still living in the wild. According to Heinrich Mendelssohn, pioneer of nature conservation in Israel and academic supervisor of the zoo, the vulture is the largest bird in Israel. Females are larger than males, reaching a weight of 13 kg (27 lb).

Before Israel's independence in 1948, there were 25-30 pairs of the Negev lappet-faced vulture, so named for the distinctive skin folds or lappets of their necks. Due to hunters, bothersome hikers and a shortage of their food supply, the number dwindled to three pairs. In 1975, the Nature Reserves Authority began to care for them. A captive breeding group was brought to the university zoo. Among them was Rosa, who became known for her attachment to her human keeper at the zoo, but despite all attempts, was unable to produce off-spring.

The news-making baby vulture is the product of birds younger than the unproductive Rosa. Previous to its birth, a vulture couple who had built a nest, had their home attacked by a jealous female, who killed the male. The widow resulting from this disaster, however, soon formed a liason with another male, producing an egg, which was removed by the researchers to encourage the pair to produce another, which they did. The first egg proved infertile and it was the second egg from which a downy white vulture chick hatched six months ago.

Zoo authorities point out that although there are many lappet-faced vultures in zoos, they have never bred successfully. □

Pitcher plants give as good as the get

Recent research has revealed the relationship between carnivorous pitcher plants and the insects they trap. Botanists had previously thought that the inflated tubular leaves known as pitchers aim to mimic flowers and so deceive insects into entering the traps. But evidence collected by Daniel Joel of the Agricultural Research Organisation in Israel suggests that the real affinity between pitcher plants and the insect they devour is one of the mutual benefit.

Joel rejects the concept that the pitcher plants are mimics. There is no evidence that insects visit the pitchers by mistake nor do researchers know of any model for any one of the traps. There is also clear evidence that the nectar produced in large amounts in the pitcher acts as a real reward for visiting insects. Some botanists have noticed that though many insects visit a pitcher, the plant catches and digests only a few of them. Pitcher plants often occur in habitats where alternative sources of nectar is an important resource for the insects there.

These plants also often grow in places which are deficient in minerals. They can, therefore, supply nectar in exchange for the mineral nutrients they obtain from the insects they trap. Although the insects learn easily that a pitcher is a source of nectar, they will not avoid it as a trap, so long as only a few of them fall prey to it. □

New Scientist

Science research centre for Bangalore

A Jawaharlal Nehru Centre for Advanced Research is being established in Bangalore as part of the Nehru Centenary Celebrations.

The Board objective of the centre will be to bring together, from time to time, top brains of the world in a given field of scientific research, Prof. C. N. R. Rao, Chairman, Science Advisory council to the Prime Minister (SAC-PM) said.

Conceptually, the centre is being envisaged as a combination of the Institute of Advanced Study, Princeton, and the International Centre for Theoretical Physics (ICTP) Trieste. It will only make use of existing infrastructure and will therefore, not cost as much as creating a new institute altogether, Prof. Rao said.

The centre, at the same time, will be an autonomous entity with enough financial support to bring together five to ten of the best people in a given field without the usual bureaucratic encumbrances that normal institutions face and provide them with an environment that could possibly bring forth new insights.

It would also serve as a place for Indian scientists to interact and give an opportunity for them to witness emergence of ideas in frontline areas of research. The centre is being planned to be set up next to the IISC for which the Karnataka Government, it is learnt, has already agreed to give land. Prof. Rao said. □

The Hindu

BOOK REVIEWS

Forty years of Plant Protection in India 1946-1986, Edited by Dr. D. Bap Reddy, 1988, 156 pp. Published by Plant Protection Association of India, Hyderabad (Price Rs. 50.00).

During the last 40 years the plant protection in the country has contributed greatly in the development of agricultural productivity and self-sufficiency, particularly in cereals. There was, therefore, an urgent need in the country to have a book highlighting the achievements in plant protection and suggesting the future strategy for improving the plant protection technology to sustain the productivity per unit area in the coming years.

The present book fulfills this task in the country. It focuses all aspects of plant protection, highlighting research, extension and development of plant protection in the country.

The present book has 18 chapters and cover all major topics like insect, disease, weed, vertebrate, and nematode management, locust warning and control, biological control, plant quarantine, pest surveillance, pesticides development and management, plant protection equipment and development, post harvest protection, integrated pest management, plant protection training and future trends including orientation. All articles have been contributed by experts well known in the country in their own specialization. The introduction and future trends have been dealt by Dr. D. Bap Reddy an eminent plant protection scientist in India and abroad. The plant protection administration and policy have been contributed by Plant Protection Adviser to Government of India, a mouth piece of the Government, so far plant protection in the country is concerned. The other contributors include prominent entomologists, pathologists, weed scientists, vertebrate pest scientists, nematologists and authorities in biological control, locust control pest surveillance, integrated pest management post harvest protection and plant protection as well as pioneers in the promotion and development of plant protection in the country.

The editor deserves congratulations in editing and compiling all the information at one place. It is hoped that the book will be quite useful and will definitely find a place in the book shelves of researchers, plant protection workers and agriculturists who are engaged in the plant protection work in the country. ☐

Caraka-Samhita (Text with English translation), Prof. P. V. Sharma, Vol. I & II ; 1983, Chaukhambha Orientalia, Varanasi, India.

Caraka-samhita is ranked as the most outstanding and authoritative work on ayurvedic therapeutics. It is Agnivesa's treatise which was refined and annotated by Caraka and later redacted by Drdhabala. The period of Caraka-samhita is around 200 B.C. Fortunately, it is among the few texts of ancient Ayurvedic compendiums which is available in complete form today. This work was so much popular that it was translated in various languages from time to time. It was translated into Persian & Arabic in 10th Cent. A.D. into English in 19th Cent. A.D., in Hindi & various regional languages of India. Also, various scholars have commented upon this text and the number of such comentories have gone up to twenty three.

This immensely valuable text had been awaiting since long a faithful and simple translation into English. This translation has been done with an idea that the connotation of the term may not be distorted and at the same time it can be handled and grasped conveniently by the scholars. It has been completed in two elephantine volumes covering five chapters in first volume and three chapters in the second. A glossary of technical terms and disease names have been included. List of floras have been given as such and with their botanical names in the appendix. Appendices on animal products, pharmaceutical processes and preparations, physiological terms, formulations etc. have been included. ☐

A. V. Sharma

Letters to the editor

Allelopathic potential of mulberry (*Morus indica*) on *Bidens biternata*

The term allelopathy has been widely accepted as the effects of one plant species on germination, growth and metabolism of plants of another or same species through reciprocal biochemical interactions[1-2]. These interactions are affected by the production and release of substances producing allelopathic effects, which are universally produced in plant world[3].

The influences of weeds on economic plants (crops) and *vice-versa* have important implications in agriculture, as these govern and direct the planning of suitable agricultural operations. Information on the allelopathy of weeds on growth and yield of agricultural economic crops are many, but unfortunately very little research has been done on the effect of economic plants on weeds[1]. Information on the allelopathic effects of mulberry on weeds may lead to a breakthrough in sericulture industry, especially for managing weeds which cause yield reductions[4], thereby leading to increased leaf production. The aim of the present investigation is to evaluate the allelopathic potential of different cultivars of mulberry, *Morus indica* L. (Local, Kanva-2, S_{30}, S_{36}, S_{41}, S_{54}) on the weed, *Bidens biternata* (Lour.) Merr. et Sherff, which infests the mulberry plantations during rainy season.

For the extract (10%), 10 gm dried leaf of different mulberry varieties were soaked separately in 100 ml distilled water for 24 hr at room temperature (28 ± 2°C) and filtered thereafter. From the stock, extract, a dilution of 1% was also prepared. For bioassay, the common Petri-dish method was followed. Observations on seed germination and linear growth of radicle and hypocotyl were recorded after 72 hr and data were statistically analysed.

The aqueous extracts of different varieties inhibited the seed germination and seedling growth of the weed in 1% extract, while the germination was totally inhibited in 10% extract of all the varieties (Table 1). In 1% extract, maximum inhibition in germination was exhibited by variety S_{41} followed by variety S_{30} as only 45% and 60% germination, respectively was obtained as against 100% in the control. Variety S_{54} showed only marginal (5%) inhibition. However, the differences observed were not significant.

As regards the seedling growth in 1% extract (Table 2), variety Local showed maximum inhibition of radicle and hypocotyl growth and the least was shown by the variety S_{30}. The order of inhibition of radicle growth was: Local $>$ S_{41} $>$ S_{36} $>$ S_{54} $>$

TABLE 1 : Effect of different concentrations of aqueous leaf-extracts of different mulberry varieties on seed germination (%) of *B. biternata*

Concentration (%)	Control	Local	Kanva-2	S_{30}	S_{36}	S_{41}	S_{54}	CD at 5%
1	100	75	75	60	90	45	95	NS
10	0	0	0	0	0	0	0	—

TABLE 2 : **Effect of 1% aqueous leaf-extract of different mulberry varieties on seedling growth of *B. biternata****

Variety	Seedling growth (cm)	
	Radicle	Hypocotyl
Control	2.58	2.65
Local	0.76	0.99
Kanva-2	1.17	1.39
S_{30}	1.64	2.14
S_{36}	0.77	1 28
S_{41}	0.69	1.04
S_{54}	0.86	1.07
CD at 5%	0.559	NS

*No germination in 10% extract

Kanva-2 > S_{30}, while for hypocotyl growth it was : Local > S_{41} > S_{54} > S_{36} > Kanva-2 > S_{30}. It is interesting to note that except for varieties S_{54} and S_{36}, the order of inhibition was same for both radicle and hypocotyl growth. The difference in growth observed for hypocotyl was drastic, but not significant statistically while for radicle it was highly significant.

The present study clearly demonstrates the inhibitory effects of the extracts from the leaves of different mulberry varieties on the germination and seedling growth of the test weed seeds, forming a biological method of weed control. By release of leachates (inhibitors) from the leaves of the mulberry varieties, the germination of the weed seeds lying in soil will be inhibited and their growth retarded, thereby leading to heavy competition by mulberry plants and finally their suppression. The radicle growth was affected more than the hypocotyl growth. This agrees with the view that young roots are more sensitive to phytotoxic effect than young shoots[5]. The order of inhibition by different varieties was to a great extent similar for both radicle and hypocotyl growth.

The present investigation thus throws light on the presence of phytotoxic compounds in the leaves of different mulberry varieties which act as growth inhibitors for the associated weeds.

Authors are grateful to Dr. M. S. Jolly, Ex-Director, for his keen interest and constant inspiration. Thanks are also due to Shri H. K. Chaturvedi for his help in analysis of data.

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Received : 1 July, 1988.
Revised : 5 December, 1988.

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Intra-increment radial variation in specific gravity in blue pine branches

Specific gravity of branches has drawn less attention as compared to stems[1*]. Branches have usually more specific gravity than stems and roots due to narrow growth rings and universal presence of compression wood on lower side[2-6]. Specific-gravity values have been shown by many workers to differ circumferentially in upper, lower and sides and also axially from base to tip of conifer branches[5], but information regarding specific-gravity changes across annual rings is lacking. The present studies were thus carried out on intra-increment radial variations in specific gravity across different types of annual rings (i.e. narrow and wide rings, compression-wood rings, and false rings with and without compression wood) met within blue-pine (*Pinus wallichiana* A. B. Jacks.) branches.

The material for this part of investigation was selected from 19 blue-pine branches and consisted of 54 annual rings representing 18 narrow rings, 4 wide rings, 8 rings with compression wood, 20 double rings and 4 double rings with compression wood and false rings. Depending upon the position of earlywood, latewood and false rings, serial tangential strips of variable thickness were cut by microtome from these selected micro-

Intra-increment radial patterns of specific gravity variation in annual increment with single growth rings

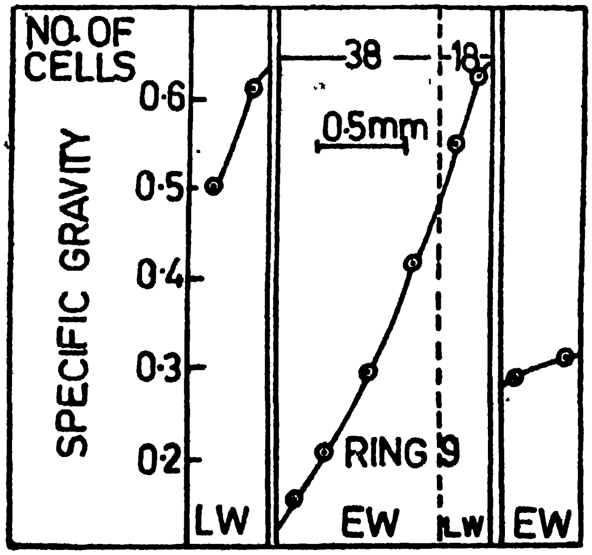

Fig. 1. Narrow ring (1.21 mm) from T_4P_1

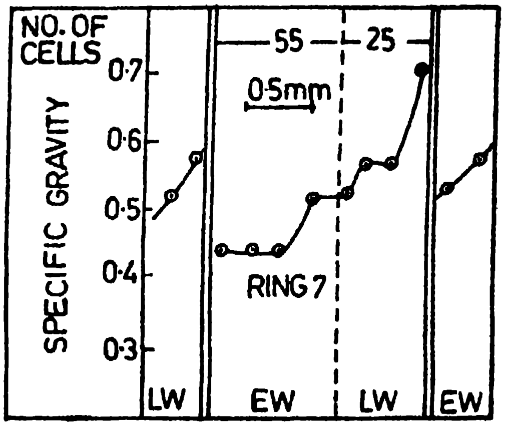

Fig. 2. Narrow ring (1.64 mm) from T_4P_2

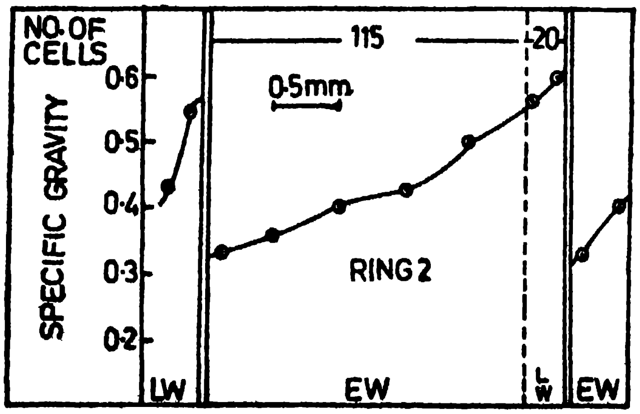

Fig. 3. Wide ring (2.69 mm) from T_4P_1

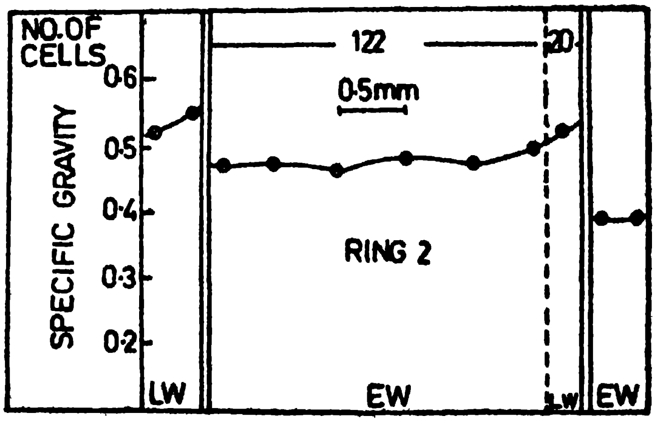

Fig. 4. Wide ring (2.84 mm) from T_4P_2

(The double vertical lines indicate annual ring boundaries; dotted vertical lines indicate earlywood-latewood transition, EW Earlywood; LW Latewood) blocks throughout their entire width alongwith a portion of adjacent rings on either side. Specific gravity of these suitably numbered strips (474 in all) were then determined by the usual oven dry weight to green volume ratio[7].

(A) Annual Increments with single-growth rings

(a) *Narrow rings* (Figs. 1-2) : In all the narrow rings (up to 2 mm width), specific-gravity increases from first-formed earlywood to last-formed latewood. The increase is usually linear (Fig. 1) or curvilinear (Fig. 2).

(b) *Wide rings* (Figs. 3-4) : The change in specific-gravity values within wide rings (more than 2 mm width) are either similar to narrow rings (Fig. 3) or increases very slowly in the latewood region (Fig. 4).

The change in specific gravity from last-formed latewood of one annual ring to the first formed earlywood of next is usually abrupt (Figs. 1-4).

(c) *Rings with compression wood* (Figs. 5-7) : An increase in specific gravity occurs in annual increments with compression wood. Within compression-wood zone, specific gravity either increases (Figs. 5-6) or remains more or less constant (Fig. 7). The influence of compression wood on specific gravity is localized, i.e. it does not influence the first-formed earlywood specific gravity of next annual ring.

(B) Annual Increments with more than one growth rings

(a) *Double rings* (Figs. 8-10) : Double rings behave as if they are two separate normal rings, with a decrease in specific gravity in each earlywood and an increase in each latewood. There is a gradual decrease in specific gravity from false latewood to false earlywood within a double ring as compared to an abrupt change from latewood of one annual ring to the earlywood of next.

(b) *Double rings with compression wood* (Figs. 11-13) : In all the double rings showing compression wood either in the first growth ring (Fig 11) or in the second growth ring (Figs. 12-13) of an annual ring, the radial pattern of the change in specific gravity shows an increase in compression wood zone, but behave normally in rest of the ring, i.e. the influence of compression wood is only localized.

Out of 54 annual rings studied, the number of rings resembling Figs. 1-13 are : 16 (Fig. 1), 2 (Fig. 2), 4 (Figs. 3-4), 8 (Figs. 5-7), 20 (Figs. 8-10) and 4 (Figs. 11-13).

It has been observed that specific gravity varies considerably within annual rings from earlywood to latewood. There is always an increase in specific gravity from first-formed earlywood to last-formed latewood. This increase can be gradual or abrupt depending upon the width of annual rings (Figs. 1-4). Specific gravity of latewood is always higher than earlywood. There is an abrupt change in specific gravity from latewood of one ring to the earlywood of following ring. In rings with compression wood, specific-gravity values increase sharply (Figs. 5-7). Within false rings (Figs. 8-13), there is a localized increase in specific gravity in each false latewood and a gradual decrease

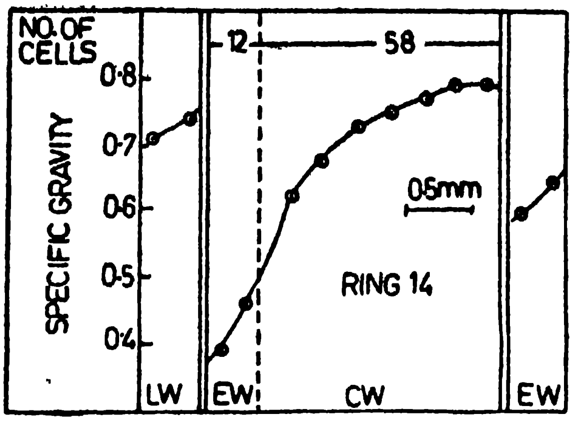

Fig. 5. Ring with compression wood (2 20 mm) from T$_4$P$_2$

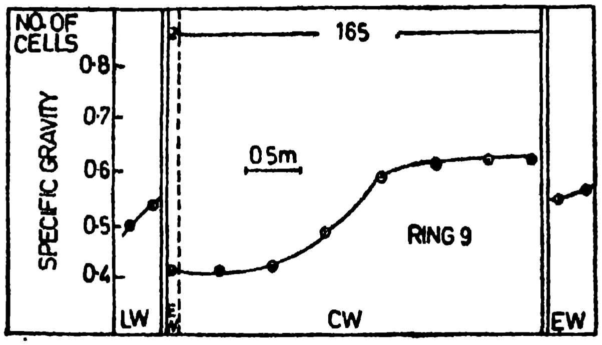

Fig. 6. Ring with compression wood (3.55 mm) from T$_4$P$_2$

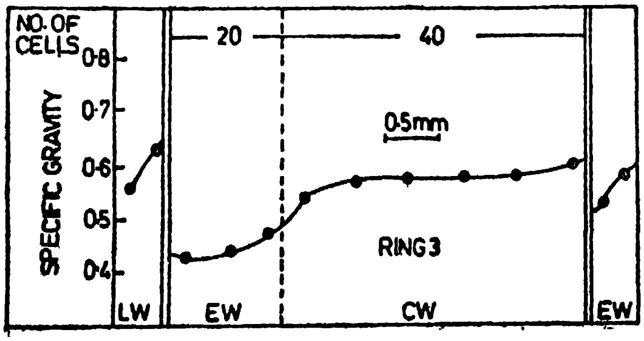

Fig. 7. Ring with compression wood (3.91 mm) from T$_4$P$_3$

(The double vertical lines indicate annual ring boundaries ; dotted vertical lines indicate earlywood-compression wood transition, EW Earlywood ; LW Late wood ; CW Compression wood)

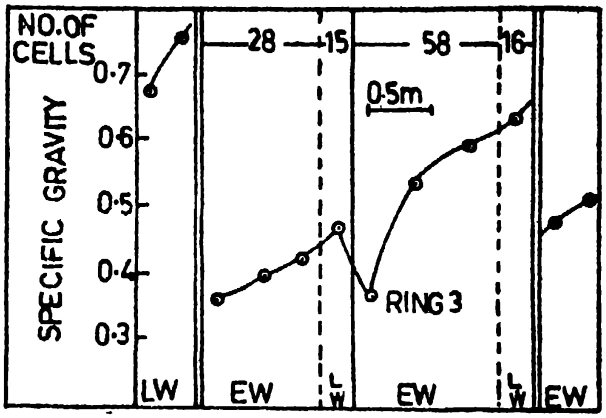

Fig. 8. Double ring (2.41 mm) from T$_4$P$_3$

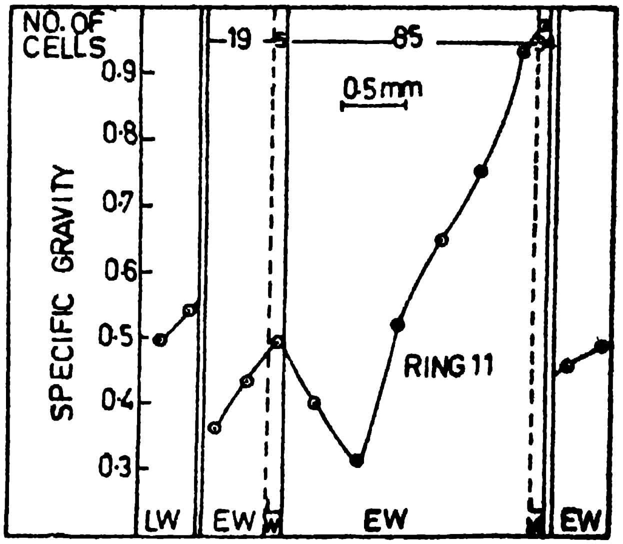

Fig. 9. Double ring (2.56 mm) from T$_4$P$_1$

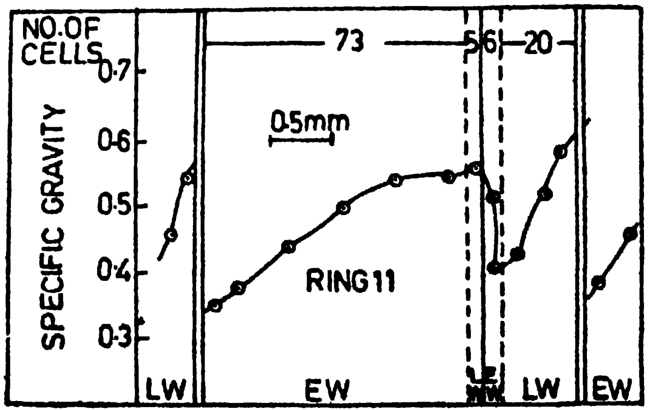

Fig. 10. Double ring (2.84 mm) from T$_4$P$_1$

(The double vertical lines indicate annual ring boundaries ; dotted vertical line indicate false rings boundary ; dotted vertical lines indicate earlywood-latewood transition. EW Earlywood ; LW Latewood)

Intra-increment radial patterns of specific gravity variation in annual increments

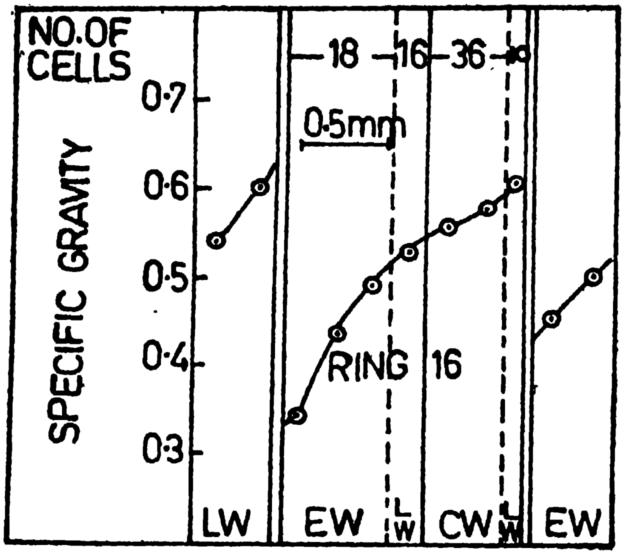

Fig. 11. Double ring with compression wood (1.35 mm) from T_4P_3

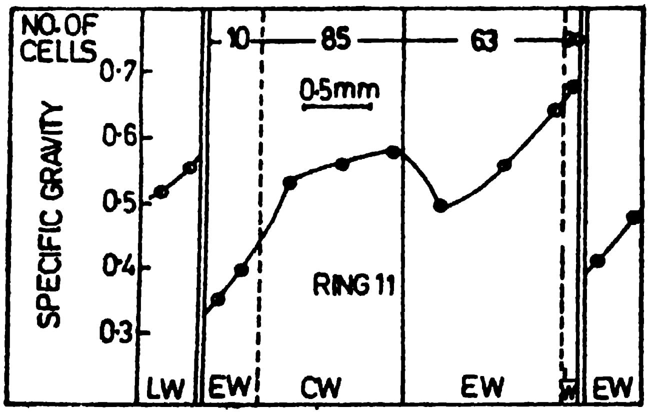

Fig. 12. Double ring with compression wood (2.84 mm) from T_4P_1

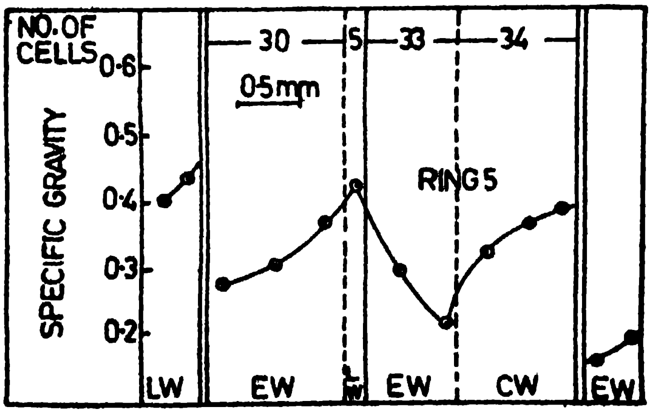

Fig. 13. Double ring with compression wood (2.84 mm) from T_4P_3

(The double vertical lines indicate annual ring boundaries; dotted vertical lines indicate earlywood-latewood or compression wood transition, EW Early-wood; LW Latewood; CW Compression wood)

in each false earlywood. The different growth rings of a false ring thus behave as separate annual rings. The present results are similar to specific gravity patterns observed within annual rings of blue stems[8-9]. As branch wood of blue pine is heterogeneous with narrow rings as in all other conifers and also because of the presence of false rings and compression wood, only whole ring samples of comparable age should be selected for comparison purposes.

We are thankful to the Chairman, Department of Bio-Sciences, Himachal Pradesh University, Shimla for providing us the laboratory facilities.

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A new dry root-rot disease of *Carica papaya* L. in Tamil Nadu, India

Carica papaya L., a well-known fruit crop of our country, is grown extensively for its nutritive value. During January 1988, Co-2 *papaya* cultivar at bearing stage was severely affected by a new root-rot disease at our University Orchard, Coimbatore. Nearly 35 5% of the plant were affected and suffered significant yield loss up to 60%.

The disease was characterised by the yellowing and dropping of leaves. Finally, the leaves dropped off. A red- to black-wet rot developed just before death and rapidly disappeared. In advanced stage of infection, the disintegration of the tissues in the lower stem portion especially near soil level was noticed in all infected plants. On such plants, pycnidia developed at the collar and on the stem 1.3-2.5 cm above ground level. Pycnidia were erumpent, oval to round with clear ostiole, 72-187 μm × 13.5-25.8 μm. Pycniospores were glassy, hyaline, elongate, 9-22 μm × 5-8 μm.

The pathogen was isolated on Potato-dextrose-agar from the infected tissues. Pycnidia were obtained successfully in a sand-maize incubated at 30 ± 2°C for 10 days. The characters of pycnidia and pycniospores closely resembled to those described by Kulkarni *et al.*[1] and, therefore, the pathogen was identified as *Macrophomina phaseolina* (Tassi) Goid. The identity of the pathogen was further confirmed by Commonwealth Mycological Institute, Kew, Surrey, England (IMI No. 322857).

The pathogenicity of *M. phaseolina* was tested on papaya cultivar Co-2 at bearing stage by introducing infested tooth picks into the stem near soil level[2]. Typical root-rot symptom similar to that of naturally infected plants was observed two months after inoculation. The occurrence of dry-root rot of on *Carica papaya* by *Macrophomina phaseolina* has not been reported so far and appears to be the first record.

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Ethylene-diamine (EDA) treatment of sunnhemp fibre

The tensile strength of natural fibres is an important parameter which decides the end uses of these fibres. Recently Chand *et al.*[1] reported the strength characteristics of sunnhemp fibre. Tensile strength of mercerised fibre has improved and is reported by several investigators[2-7]. The improvement in strength may be due to the strengthening of weaker points. McDonald *et al.*[8] reported that less uniform cotton showed more improvement in strength on mercerisation that better cottons.

Ethylenediamine (EDA) forms complexes with cellulose. The decrystallization, the degree of crystallinity, etc. of cotton fibres swollen in EDA have been extensively studied by several workers[8,9]. Howsman and Sission[10] suggested that the amines penetrate the crystalline regions by breaking the hydrogen bonds lying mainly in the (002) plane. Cross-linking of the cellulose molecule via EDA molecule is envisaged and, as a consequece,

TABLE 1 : UTS and Moisture Content Values of EDA treated and raw sunnhemp fibre

Sample	Speed of testing	UTS MN/m^2	Standard deviation	% strain	Moisture content
Sunnhemp fibre	0.02m/min	186	—	2	8.04%
2% EDA treated Sunnhemp fibre	0.02m/min	418	4.12	1	2.2%
5% EDA treated Sunnhemp fibre	0.02m/min	497	5.74	1 2	3 5%

rotation of the anhydroglucose units is stopped. In the previous study, we had acetylated sunnhemp fibres and determined the properties of acetylated fibre. In this study, we have treated the sunnhemp fibre with EDA and measured the change in strength and surface of sunnhemp fibre. Sunnhemp fibre was obtained from Jabalpur region with the help of Khadi Village and Industries Commission (KVIC), Bhopal, India, and was given treatment in 5% and 2% EDA for 10 min under slacked condition. Longitudinal section (LS) and strengths of untreated and EDA treated sunnhemp fibres were observed on scanning electron microscope (Model JEOL 35C) and on Instron. Moisture content was determined or IR moisture balance.

Table 1 lists the strength and % strain of sunnhemp fibre and of EDA treated fibres. These values have been determined at a cross head speed of testing of 0.02 m/min. Table 1 shows UTS and moisture content values of EDA-treated and raw sunnhemp fibre. Moreover, 98% EDA treatment was known to increase the amount of disordered regions in the fibre. Decrystallization occurred by EDA treatment might have changed the state of clustering of the fibrillar structure. Kalyanaraman[11] pointed out that the yield point was mainly decided by the space order, namely

Fig. 1. Longitudinal section (LS) of sunnhemp fibre

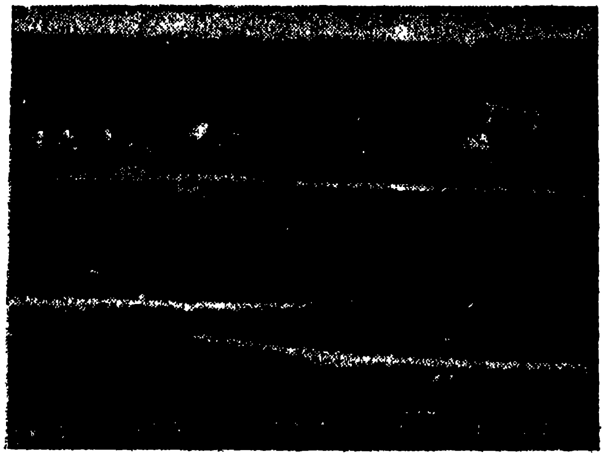

Fig. 2. Longitudinal section of EDA (5%) treated sunnhemp fibre

the crystallinity of the fibre. Orientation changed as a result of EDA swelling[11]. Less percentage of EDA treatment might strengthen the weaker points. Fig. 1 shows the longitudinal section of sunnhemp fibre and Fig. 2 shows EDA treatment which has changed the surface of the fibre, as reported by Evans and Jeffries[12]. In the present study, the mechanical properties of EDA-treated sunnhemp fibre was different from the mechanism known cotton. In this case, EDA smoothened the surface and strengthened the weaker points and hence EDA treatment slightly improved the strength of sunnhemp fibre. The tensile strength of 2% EDA treated sunnhemp fibre had changed from 186 to 418 MN/m^2. EDA treatment had reduced the hygroscopicity as compared to raw sunnhemp fibre.

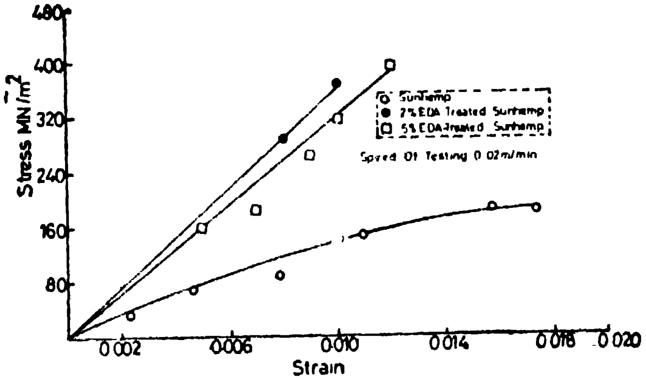

Fig. 3. Strees-strain curves of sunnhemp and EDA treated sunnhemp

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Effect of carbon and nitrogen sources on antagonistic activity of *Trichoderma harzianum* against *Rhizoctonia bataticola*

Trichoderma spp. have been proved to be useful in achieving biological control of various soil borne plant diseases[1,2]. *Rhizoctonia bataticola* causing dry root rot of groundnut results in severe losses in Marathwada region. To study the possibilities of controlling the disease using *Trichoderma harzianum*, *in vitro* experiments were conducted to see the effects of different nitrogen and carbon sources on its antagonistic and parasitic activities.

Fourteen different carbon and 13 nitrogen sources (at 1% and 0.25% concentrations and listed in Tables 1 and 2 respectively) were substituted for glucose and potassium nitrate in glucose nitrate (GN) medium. Parasitic activity was studied by the spot inoculum test on GN agar plates. The plates were incubated for 96 hrs at 28 ± 1°C and the per cent

TABLE 1 : Effect of carbon sources on antibiotic and parasitic activity of *T. harzianum* against *R. bataticola*

Carbon sources	Antagonistic activity		Parasitic activity % inhibition of *R. bataticola*
	Dry Wt. of *T. harzianum* (mg)	Inhibition zone (mm)	
Mannose	189	0.0	76.4
D-xylose	242	7.0	94.2
Lactose	243	6.5	0.0
Galactose	223	5.0	86.0
Cellulose	307	5 0	88.0
Sorbose	141	3.0	79 0
Sucrose	171	5.0	95.8
Fructose	190	4.5	83.3
Inulin	182	4.0	70.0
Maltose	188	3.5	75.0
Rhamnose	195	4.5	83.3
L-Arabinose	175	4.6	83.5
Starch	180	4.0	75.0
Glucose (Control)	205	5.0	85.0
CD at 5% level of significance	±8.86	±0.039	± 6.82

decrease in colony diameter was measured when *R. bataticola* and *T. harzianum* were inoculated side by side 3 cm apart.[8] Antagonistic activity was determined by agar-well technique. Agar-wells of 8 mm diameter were made with the help of a cork borer in pathogen seeded GN agar (40 ml agar medium petri-plate of 9 cm diameter) in triplicate. Agar-well was filled with 0.4 ml of 10 day old cell-free culture filtrate of *T. harzianum*. The clear zone was measured around the agar-well after incubating for 96 hrs at 28 ± 1°C.

It is clear from Table 1, that D-xylose and lactose favoured better growth of *T. harzianum*

TABLE 2 : Effect of nitrogen sources on antibiotic and parasitic activity of *T. harzianum* against *R. bataticola*

Nitrogen source	Antagonistic activity: Dry Wt. of *T. harzianum* (mg)	Antagonistic activity: Inhibition zone (mm)	Parasitic activity % inhibition of *R. bataticola*
Sodium nitrate	146	3.0	75.00
Amm. nitrate	246	7.0	90.77
Peptone	268	2.0	94.60
Amm. chloride	159	4.0	100.00
Casein hydrolysate	168	6.0	87.50
Ca-nitrate	202	3.0	70.00
Amm. sulphate	128	2.5	84.70
Amm. bisulphate	135	4.0	80.70
Sod nitrate	183	5.5	96 10
Amm. oxalate	190	4.5	77.70
L-Asparagine	185	4.6	83.30
Pot. nitrate (Control)	205	5.0	85 00
CD at 5% level of significance	± 10.89	± 0.38	± 2.46

and also showed maximum production of antagonistic zones (7 and 6 mm respectively). Sorbose and mannose were unfavourable for the production of antagonistic factor. Other carbohydrates gave insignificant results.

Regarding the parasitic activity, sucrose followed by D-xylose favoured maximum per cent inhibition of *R. bataticola* colony in presence of *T. harzianum*, viz. 95.8% and 94.2% respectively (Table 1).

From Table 2 it is clear that ammonium nitrate proved to be the best nitrogen source followed by casin hydrolysate giving clear zones of 7.0 and 6.0 mm respectively. Peptone, although supported best growth of *T. harzianum* on the basis of dry weight of mycelial mat, showed a reduced zone of inhibition (2.0 mm).

Addition of ammonium chloride, ammonium nitrate and peptone to GN medium showed a significant reduction in the per cent colony diameter (100.00, 90.77 and 94 60 respectively). Ammonium molybdate was found to be toxic to both pathogen as well as antagonist. Other nitrogen sources showed either insignificant reduction in the diameter of the pathogen colony, or promotive effects.

Present investigations on the antagonistic and parasitic activity of *T. harzianum* against *R. bataticola* indicated the possibility of its use in biological control of dry root rot of groundnut. However, field trials are needed to confirm the biological control of *R. bataticola* in soil and on the roots of groundnut.

We are thankful to U.G.C. for awarding Research Associateship to one of us (M.C.)

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Received : 28 June, 1988.
Revised : 15 November, 1988.

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A case of sexual dimorphism in *Xenentodon cancila* (Hamilton) from Pong reservoir, H. P.

The occurrence of sexual dimorphism is a common feature among fish species. The sexual characters which separate the female fish from the male normally develop with the approach of the spawning season. In several fish species the male specimens develop tubercles, bright coloured fins, roughness of the ventral side of pectorals etc.[1-3] The occurrence of sexual dimorphism in *Xenentodon cancila* (Hamilton) in the Beas system is perhaps the first record.

During sampling of Pong reservoir for limnological and fishery studies, several specimens

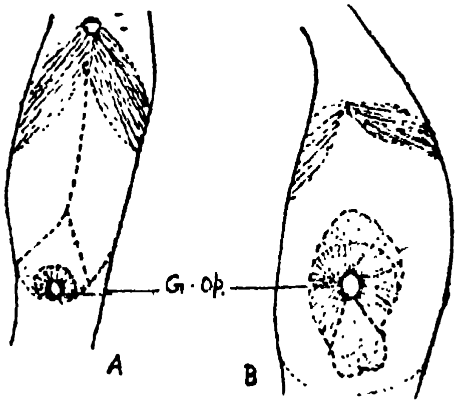

Fig. 1. Diagramatic representation of ventral part of *X. cancila* showing the difference in anal region of the body. A—Male ; B—Female ; G. Op. genital opening.

Fig. 2. Photograph of male and female of *Xenentodon cancila* (Hamilton) caught from Pong reservoir in Himachal Pradesh.

TABLE 1 : **Difference between male and female of *X. cancila* recorded from Pong reservoir, Himachal Pradesh**

Characters	Male	Female
Shape of body	A hump in the mid dorsal region, just behind the head groove	Hump absent
Vent	Small deep pit-like	Projecting like a small papilla with a narrow median silt
Abdomen	Not rounded	Rounded, bulging
Body colouration :		
Abdomen	With yellow patches upto pelvic fin, rest white	White
Dorsal (above lateral line)	Olive green	Olive green pre-dominant with greyish tinge
Average Length	24.4 cms	25.7 cms
Average weight	34 gms	45.7 gms

of *X. cancila* showing distinct sexual dimorphism were collected during July-August 1986. In Table 1, characters, which distinctly distinguish the male from the female specimens, are given (Figs. 1 and 2).

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Revised : 12 September, 1988.

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Absence of compression wood in buried roots of blue pine

Reaction on wood is generally developed on the lower abaxial side of leaning stems and branches in gymnosperms (except Cycadales and Gnetales) and is called compression wood.[1]

During the course of investigations on root wood[2], it was observed that wide rings were not due to the development of compression wood (Fig. 1). It is entirely lacking in all the buried roots of blue pine. The latewood tracheids in these buried roots tend to be flattened and less lignified. Blue pine stems[3-9] and branches[10], on the other hand, have been shown to possess compression wood. The absence of compression wood in buried roots of blue pine is in confirmation with the findings of many others in this field[1]. The

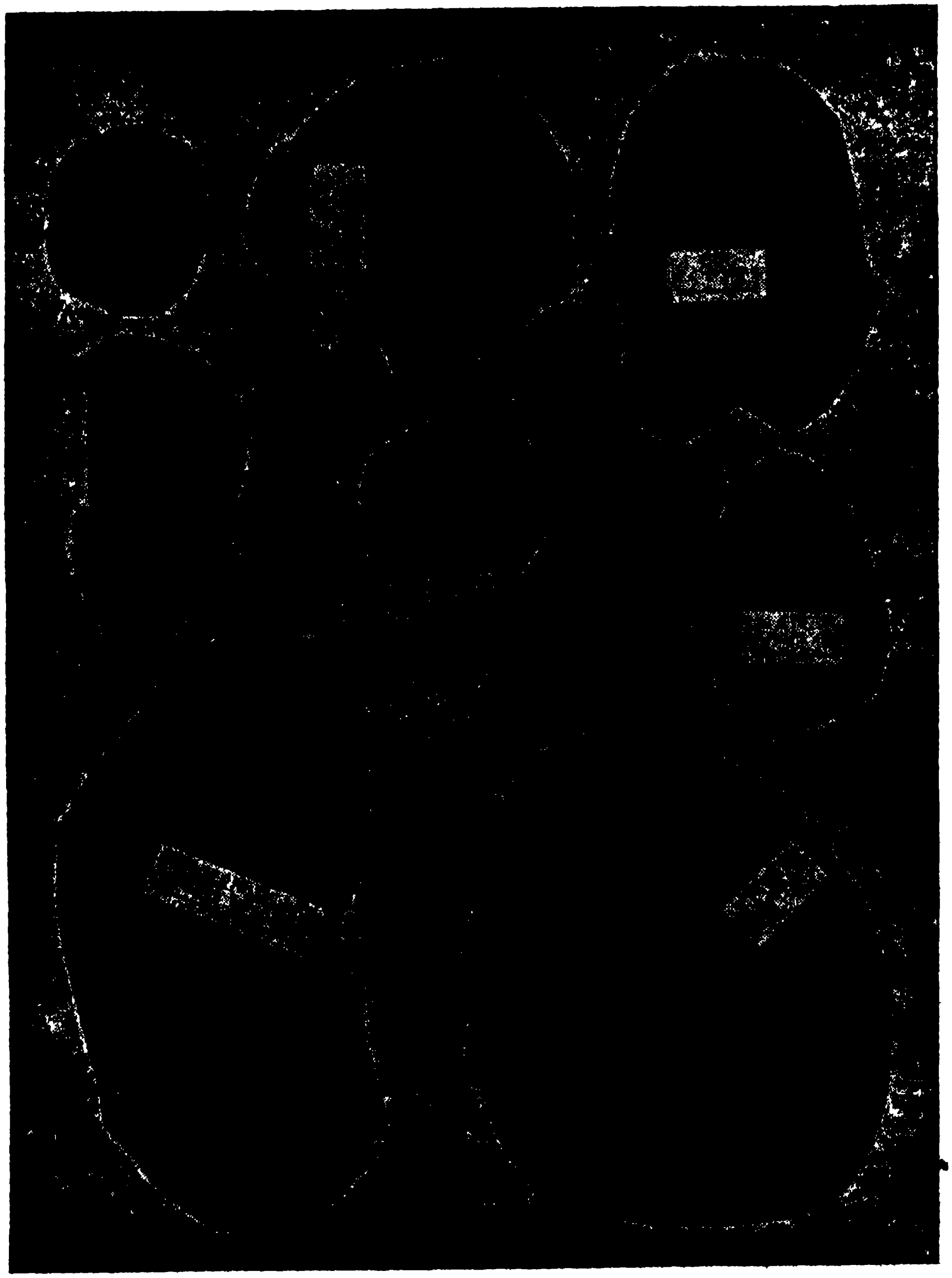

Fig. 1. Cross-sections of blue pine roots. A-T_1RV_1, B-T_1R_1, C-T_2R_1, D-T_2R_2, E-T_3R_2, F-T_4R_2, G-T_4R_1 and H-T_2R_2 U refers to the upper side. The wide growth rings on upper side of roots are not due to compression wood formation.

only authenticated report of compression wood in underground roots is that of Westing[11] in *Thuja canadensis*. However, exposed roots of conifers generally develop compression wood[1].

We are thankful to the Chairman, Department of Bio-Sciences, Himachal Pradesh University, Shimla for providing laboratory facilities. The second author is thankful to University Grants Commission, New Delhi for financial assistance.

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Studies on Feulgen staining of DNA with toluidine blue O-SO_2 with special reference to their shelf-life

Toluidine-blue O (TBO) is a dye showing considerable difference in the shelf-life when prepared as dye-reagents with different organic and inorganic acids along with potassium metabisulphite.[1-8] When prepared as a dye-reagent with citric acid and metabisulphite, shelf-life is about four weeks, whereas with tartaric acid shelf-life is extremely low. This investigation was undertaken to study the shelf-life of TBO-SO_2 prepared with benzoic acid and metabisulphite, and to find out whether (i) this dye is an aqueous solution can be used in Feulgen procedure to stain nuclei in tissues fixed in different fixatives, (ii) TBO-SO_2 prepared with benzoic acid and metabisulphite but fortified with disodium hydrogen phosphate and glycine can have better shelf-life than ones without these reagents and having a comparatively lower pH and (iii) TBO-SO_2 prepared as above but shaken with activated charcoal has a longer shelf-life than the one without charcoal treatment.

Toluidine-blue O (E. Merck, C. I. No. 52040) is a thiazine dye and is provided with a primary amino group in its molecule. The dye-reagents employing this dye were prepared as follows : To each of the four separate lots of 100 ml of warm distilled water was dissolved 500 mg of the dye, 500 mg of benzoic acid 1.0 gm of potassium metabisulphite. One of these was fortified with 500 mg of disodium hydrogen phosphate and the other with an equivalent quantity of glycine. The last one was without these reagents but was shaken with 1.0 gm of activated charcoal and filtered. The reagents, after filtration, appeared to be deep blue in colour and registered pH of 3.5, 4.5, 3.7 and 3.6 respectively. All the four reagents were stored in the refrigerator during the span of the experiments.

The materials used were liver, kidney, testis and rectum of a white rat that were fixed in formalin, Lewitsky, Bouin and Helly. Paraffin sections (8 μm) were used. For staining, deparaffinised sections were hydrolysed in 6N HCl at 35°C for 10-12 min, rinsed with water, stained with the reagents for 10 min, rinsed with water, treated with 0.05N HCl for 1 min, rinsed with water, dried between folds of filter paper, treated with *n*-butanol for 1-2 min, cleared with xylene and mounted in DPX. An aqueous 0.5% solution of the dye was also used for staining following Feulgen hydrelysis. Microscopic examination of sections of tissues fixed in formalin, Lewitsky, Bouin and Helly when stained with TBO-SO_2 prepared without disodium hydrogen phosphate and glycine revealed perfect colouration of the nuclei following Feulgen hydrolysis. Stained preparations did withstand a very brief treatment in 0.05N HCl, revealing sky-blue nuclei except in Bouin-fixed tissues which showed considerable leaching of the dye from the nuclei. Without acid-water treatment, the nuclei appeared to be deep violet. When stained with reagents fortified with disodium hydrogen phosphate or glycine, the nuclei appeared to be bluish-violet. These preparations withstood a very brief treatment in acid water with considerable loss of stain from the nuclei. However, sections of tissues fixed in all the fixatives except in Bouin could after staining be dehydrated through grades of ethanol revealing bluish-violet nuclei. Staining time for all the tissues was 10 min. TBO-SO_2 shaken with activated charcoal also yielded perfect nuclear colouration.

Formalin-fixed sections required long period for optimum staining when stained with an aqueous solution of the dye. Bouin-fixed tissues did not take stain even when staining was performed for 3 hr. Sections of tissues fixed in formalin could be stained with an aqueous solution of the dye provided staining was performed for 2-3 hr, although the first visible sign of nuclear colouration resulted after 30 min of staining in these tissues, Helly and Lewitsky-fixed tissues required only 10 min of staining in order to obtain optimum nuclear colouration which was sky-blue. None of the tissues fixed in the four fixatives could be treated with acid water, since following this treatment nuclear colouration was totally negative. Therefore, effective staining with an aqueous solution of the dye on sections of tissues fixed in the four fixatives required drying between folds of filter paper followed by one minute treatment in *n*-butanol, clearing in xylene and mounting. Formalin, Lewitsky and Helly-fixed tissues could be dehydrated through the regular grades of ethanol, keeping briefly in each grade with slight loss of stain from the nuclei.

The shelf-life of benzoic acid-metabisulphite reagent is 12 days and that of the one fortified with glycine 10 days. The shelf-life of these two reagents, however, could be increased to at least a month provided their pH were increased from 3.5 to 4.0 with the addition of a small quantity of disodium hydrogen phosphate or 0.1N sodium hydroxide. The shelf-life of TBO-SO_2 fortified with disodium hydrogen phosphate is four weeks and the same is the shelf-life of the one treated with activated charcoal.

From the foregoing results, it is evident that TBO-SO_2 prepared with benzoic acid-metabisulphite is quite suitable for *in situ* demonstration of DNA following Feulgen procedure. An aqueous solution of the dye can also be used for the same purpose, provided staining is performed for a long time. Since preparations stained with an aqueous solution of the dye show complete leaching of the dye from the nuclei when treated with acid water, it is logical to conclude that the dye molecules get loosely bound with the DNA-aldehyde molecules so that the complex is soluble in it. Bouin-fixed tissues cannot be stained with an aqueous solution of TBO. This phenomenon may be partly true for formalin-fixed tissues but is not true of Lewitsky and Helly-fixed ones. In the latter cases, perfect and specific nuclear colouration results when staining is performed for 10 min.

Studies on the shelf-life of TBO-SO_2 reagents indicate that this is dependent on the hydrogen-ion concentration of the dye-reagents. This is due to the fact that the shelf-life of a reagent prepared with benzoic acid and metabisulphite, fortified with disodium hydrogen phosphate with pH 4.5, is much more than the one without it and showing pH 3.5. Similar phenomenon could not, however, be obtained from the reagent fortified with glycine ; this reagent did not show any rise in pH over the control. A more or less similar observation was recorded by the author in an earlier publication[3] in which TBO-SO_2 reagent prepared with 1N H_2SO_4 and metabisulphite when treated with charcoal at pH 2.5 was found to have a shelf-life of 7 days as compared with one not treated with charcoal. This latter reagent at pH 2.5 had a shelf-life of 5 days. The present study and the earlier one clearly prove that organic acid like benzoic is better suited in the preparation of TBO-SO_2 reagent than mineral acid, such as sulphuric. Earlier study of the author[1] that shows TBO-SO_2 reagent prepared with citric acid-metabisulphite with pH 2.5 has a shelf-life of about one month. Moreover, TBO-SO_2 reagent prepared with phosphoric acid-metabisulphite but fortified with glycine has a shelf-life of only 7 days[2]. As found from the present study, the shelf-life of the two reagents, one prepared with benzoic acid-metabisulphite and the other fortified with glycine, after the expiry of their staining ability, can be increased if their pH are raised from 2.7 to 3.2 and 3.5 to 4.0 respectively with the addition of small quantity of disodium hydrogen phosphate in one case and 0.1N sodium hydroxide in the other. Under these conditions, specific nuclear colouration results even after these reagents are stored in the cold for four weeks. All these observations do, therefore, support the statement made above that the shelf-life of TBO-SO_2 reagents depends upon their hydrogen-ion concentration. A minimum pH is essential to obtain specific colouration of the nuclei. The two reagents whose shelf-life varies from 10-12 days have pH of 3.2 and 2.7 after four week of storage in the cold and these pH are less than the minimum necessary to obtain perfect staining.

The pH of the four TBO-SO_2 reagents prepared with benzoic acid and metabisulphite does not remain stable on being stored for some days in the refrigerator. The pH measurements in all of these indicate a gradual drop after storage in the cold for several days. However, such a fall in pH does not seem to have any adverse effect on the staining ability of the dye-reagents at least up to a duration of one month in some cases. Preparations stained with any of the four reagents after storage for days cannot be treated with acid water, since this procedure causes considerable loss of stain from the nuclei. However, preparations without acid-water treatment reveal perfect and specific staining of the nuclei which are of bluish-violet colour as compared with the sky-blue nuclei after acid water treatment.

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Received : 20 July, 1988.

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A new pseudostem-rot disease of robusta banana in Tamil Nadu

Banana (*Musa* sp.) cv. *robusta* is one of the important fruit crops grown extensively in many parts of Tamil Nadu. During October-November 1987, a new pseudostem-rot disease was observed on 3-5 month-old robusta banana in the experimental plots at the University Farm, Coimbatore. The disease incidence was recorded as 7-8%. Initially, the pathogen produced water-soaked lesion at the base of pseudostem near soil level. The lesion later developed into a necrotic zone with yellowish-white centre and dark-brown margin. On the necrotic spot, chocolate-brown and rape-seed like sclerotia along with white mycelium were seen. The affected plants showed yellowing, followed by wilting and drying and finally resulting in the death of the plants.

The fungus was isolated from the affected tissues on potato-dextrose-agar medium. The fungus grew in fan-shaped manner and profuse mycelium appeared in 3-4 days and sclerotia developed after 15 days. The sclerotia were chocolate-brown in colour and ellipsoidal in shape. The size of the sclerotial bodies varied from 0.4 to 1.2 mm. The characters of the fungus closely resembled those described by Siddaramiah and Siddaramappa[2] and identified as *Sclerotium rolfsii* sacc. anamorph of *Corticium rolfsii* (Sacc.) Cruzi. The identity of the fungus was confirmed at Commonwealth Mycological Institute (IMI No. 322862).

The pathogenicity of the fungus[1] was established by inoculating pseudostems with mycelial bits of one-week old culture and incubating them in humid chamber at 25°C. Rotting and shredding of pseudostem was caused within 5 days after inoculation. The rot extended both upwards and downwards from the seat of infection. The pathogen was re-isolated and the sclerotia were larger than those formed naturally on the pseudostem. *Sclerotium rolfsii* has been known for its cosmopolitan occurrence as an incitant of root- and stem-rot diseases, having an extensive host range[3,4]. The incidence of pseudostem-rot on banana by *Sclerotium rolfsii* has not been reported so far and appears to be first record.

The authors are thankful to Dr. J. E. M. Mordue, Commonwealth Mycological Institute for identification of the fungus.

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Received : 1 July, 1988.
Revised : 19 December, 1988.

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(i) R. B Walton and H. B. Woodruff, *F. Clin. Inst.*, **82**, 924, 1949.

(ii) W. C. Boyd, Fundamentals of Immunology, 1947, p. 123. (Interscience Publishers Inc., New York).

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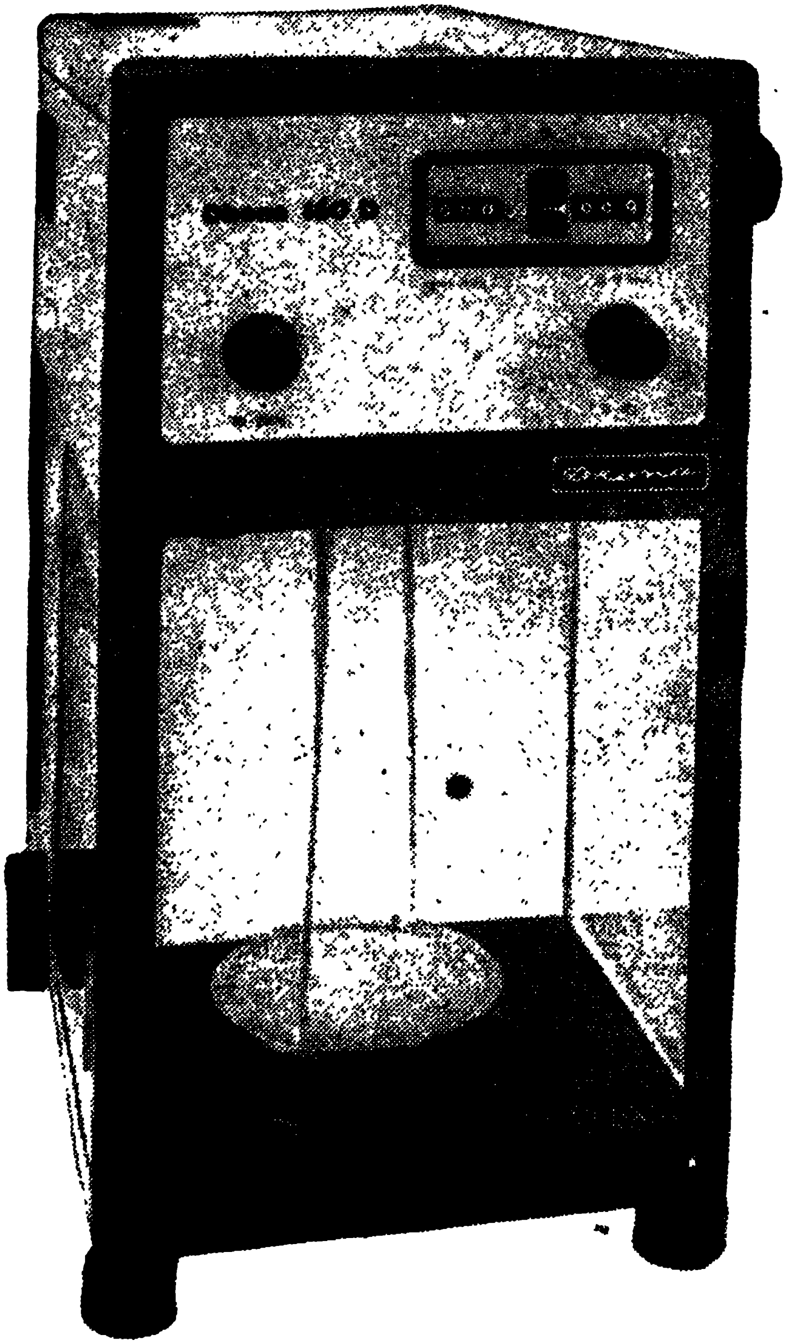

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92, Acharya P. C. Road, Calcutta-700 009 at B. G. ART PRINTERS ★ CALCUTTA-700 054.

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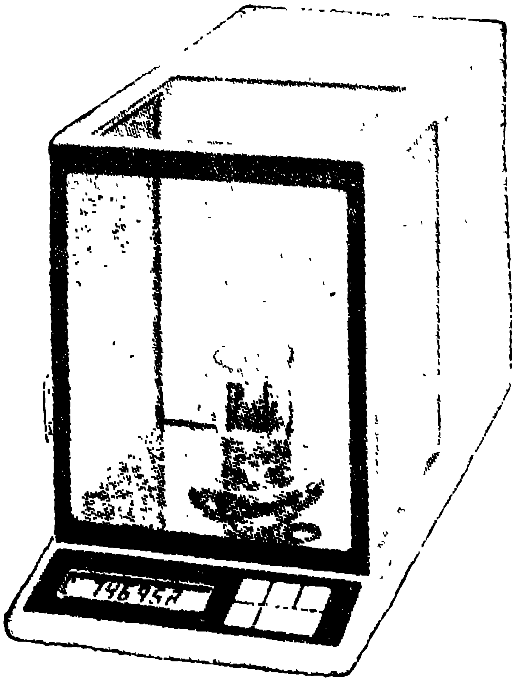

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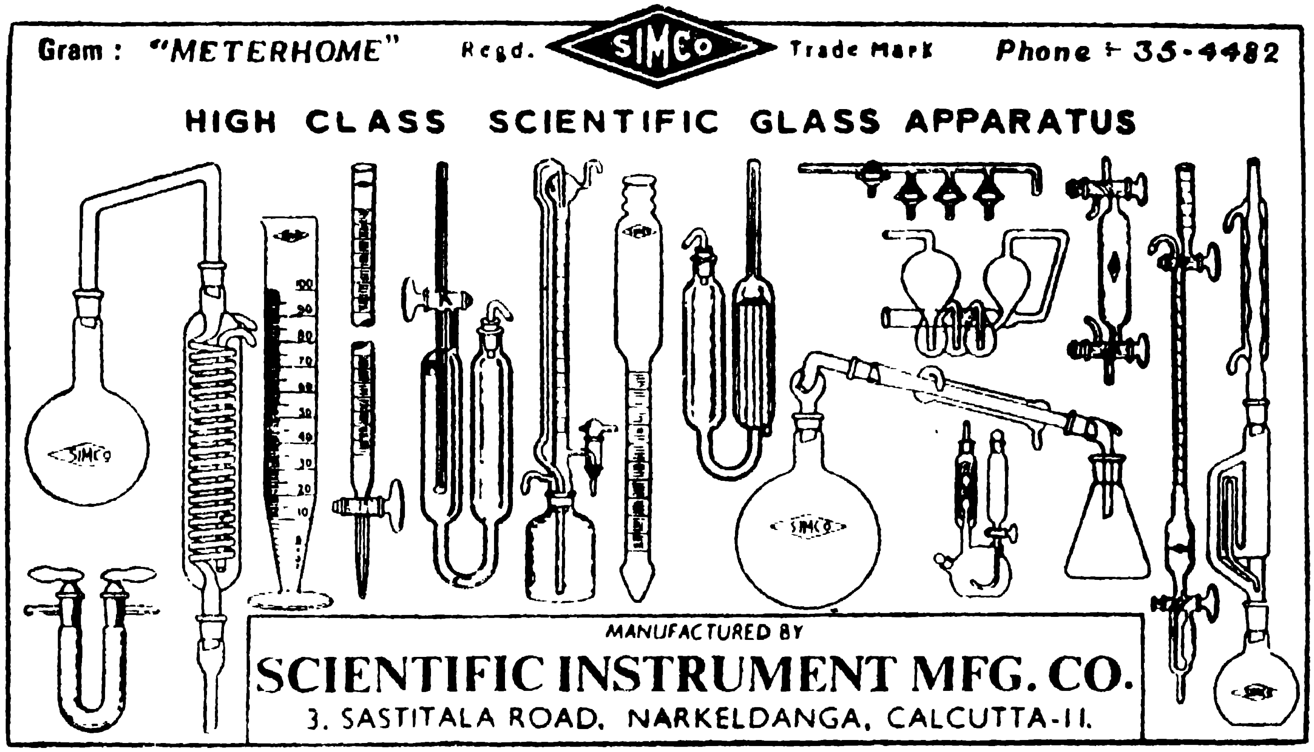

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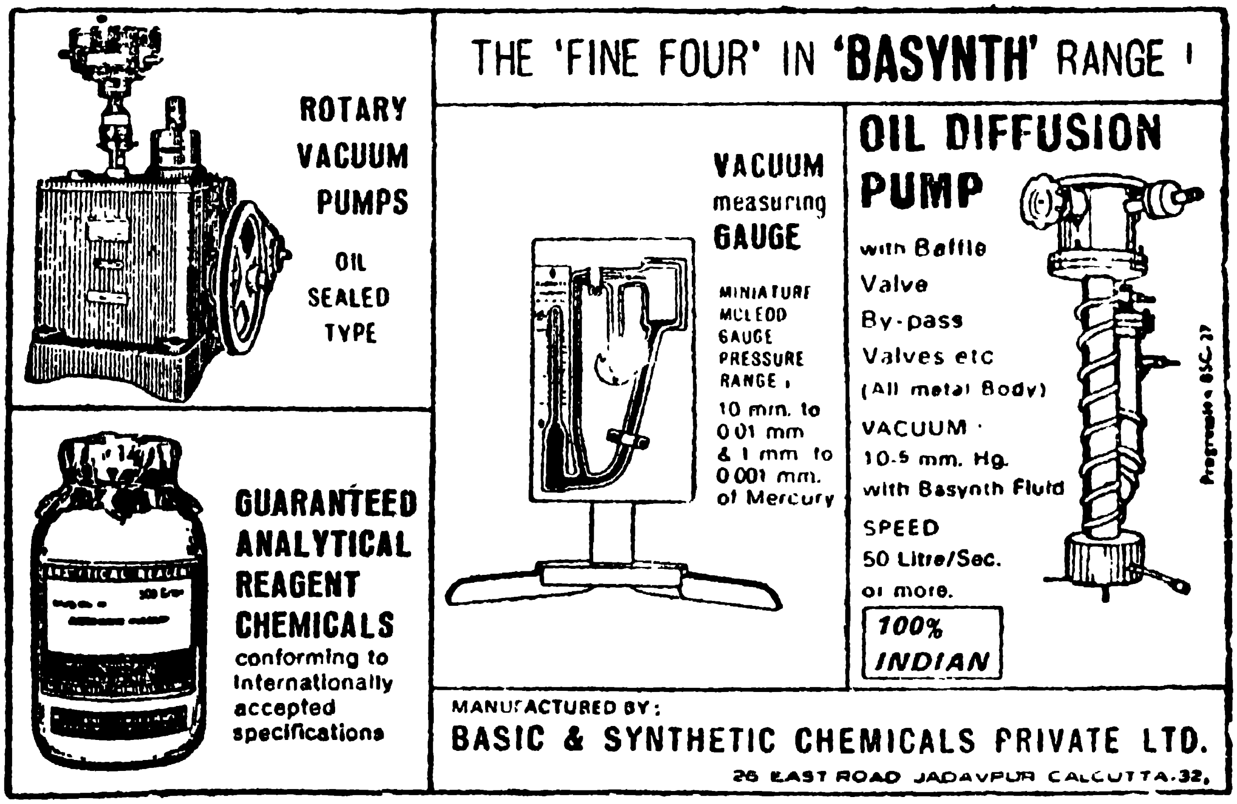

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May 1989 / Volume 55 / Number 5

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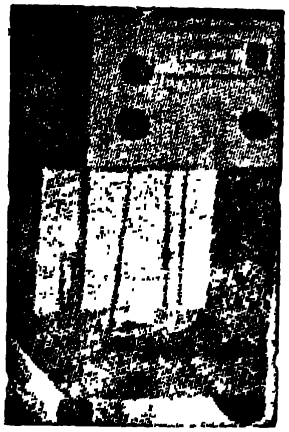

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TRIBUTE TO THE SILENT ARCHITECT OF MODERN INDIA*

MANY were the great and remarkable personalities who were born in the last century who taught the people to live with self-respect and ultimately won political independence. The names of Dadabhai Naoroji, Bal Gangadhar Tilak, Pherozshah Mehta, Motilal Nehru, Gopalkrishna Gokhale, C. R. Das, Vallabhbhai Patel, Jawaharlal Nehru, Maulana Abul Kalam Azad and most of all Mahatma Gandhi stand out. However, there is one name which is not remembered in the above stream but revered and cherished by every Indian as the silent architect of modern India and that is Jamsetji Nusserwanji Tata whose 150th birth anniversary was celebrated in early March.

J. N. Tata was born at Navsari, Gujarat on March 3rd, 1839. This was one of the darkest periods of the Indian history when the grip of foreign rule and the exploitation was at its peak. With their spirits broken, their social and economic life at a low ebb, the people of India sought solace either in religious practices or futile remembrances of the country's past glories. Thus time was ripe for the advent of a man who could lead his country men, a man who sees ahead of his times, shaping the future out of the lessons of the past and honed by the experiences of the present. Jamsetji Tata was such a man, born in a highly successful business family, he himself became a businessman to the core and he made the progress of the nation his business. His early education was in arithmetic and Gujarathi at his native place until the age of 13 when his father Nusserwanji who was a successful businessman in Bombay, brought him over to city, where he entered the Elphinston Institute at the age of 14 and there he acquired an abiding love for English literature. He was fond of Charles Dickens, Thackeray and Mark Twain. Reading was one of his main indulgences and a love for good food being the other. He passed out of college in 1858, when the Indians had not yet recovered from the stunning blow of Britain crushing the 1857 revolt. Jamsetji joined his father in business and opportunities came one after another in his way to prove his mettle.

The American civil war brought a boom in the cotton trade and the Tata's fortune soared with it as the Lancashire mills started feeding cotton of Indian origin. However, it was a short lived euphoria as it died with the end of the war. Many traders were completely ruined but Tatas could bear the shock. This short term engagement of their attention gave an opportunity to young Jamsetji to carefully study the working of the textile mills in England and to establish the Empress Mills at Nagpur amidst the cotton growing area. The successful operation of this followed the purchase of some sick units in Bombay which were put firmly on the rails in a reasonable time.

---

* Information based on the Newspaper supplement on 150th birth anniversary of J. N. Tata.

Though JN became a successful mill owner, his concern for his fellowmen and the state of his country were not brushed aside while riding on the wave of success. Many were the political leaders who had made it their profession to fight for freedom and had adopted the public platform. But JN had silently assessed the situation and also worked silently without much publicity. He introduced welfare measures for his mill workers whereas the Lancashire mill-owners were extracting 12-16 hours of work from them, unconcerned about the men on the shopfloor. JN introduced sanitary hutments and filtered water for the factory workers. The first factory dispensaries were opened in Nagpur and in 1885 a pension fund was introduced. Before the close of the century in 1896 accident compensation was also introduced.

These measures were not introduced to claim any laurels and gain any advantages. But it was an inner urge to treat the workers as human beings and partners in progress. No government ordered him to part with his wealth for the workers nor were there trade union movements to compel him to share it. It was the vastness of his heart that moulded his character and made him sensitive to the feelings of the people around him.

In 1889, JN was stirred by a speech of Lord Reay, Governor of Bombay calling for 'real universities which will give fresh impulse to learning, to research, to criticism, which will inspire reverence and impart strength and self-reliance to future generations'. Universities in those days were only the examining bodies and the colleges used to do the teaching and there was hardly any research anywhere. After pondering over the matter, when he was actually giving shape to his plans, JN wrote a letter to Lord Reay in 1896 offering half his fortune, properties worth Rs. 30 lakhs (of those days) to create such a university.

In the meantime he had sent his emissaries abroad to look for a model university. He spelt out the kind of university he wanted. It was to be a seat of learning and research for engineering, physics and all branches of chemistry, as also a centre where Indian history and archaeology were researched into and where statistics and philology were advanced.

In October 1899, JN was invited by Lord Curzon to attend a conference on education at Simla and at the conclusion of the same a Government resolution expressing confidence in his proposal said "that the proposed university will meet a great need, and will contribute to the advancement of higher education and development of the resources of the country".

In 1900, when JN visited England he requested the Royal Society to recommend a suitable scientist to visit India to report on the feasibility of the scheme. Professor Ramsay (later receipient of the Nobel Prize) toured India and suggested that the British Government should give at least £ 5,000 a year if not £ 8,000 to match JN's contribution. A committee under the chairmanship of Justice Candy, Vice-Chancellor of Bombay University was formed to promote the scheme. It did not materialise during JN's life time but he had made adequate provisions in his will.

While the education plan was being presented to the Government, JN was thinking of how to move ahead with his second scheme to set up a steel plant. In 1882 when he conceived this idea, he himself carried samples of iron ores and coking coal to Germany for testing. But the coking coal was of a poor quality and the scheme had to be shelved until a report in 1899 announced that Jharia coal fields had adequate coking coal which revived his plans. He obtained support from the Secretary of State for India and applied for prospecting licences for iron ore, coal and fluxes. He proceeded to the United States to study the steel industry.

The townships around Sheffield in England and Pittsburgh in the States, both known for their steel works, had come up haphazardly around the works. JN directed his son in very clear terms before chosing the location of the future township of their steel works, to ascertain the direction of the prevailing winds so that the factory smoke and fumes would blow away from the workers dwellings. He wrote to Dorab in 1902.

"Be sure to lay wide streets planted with shady trees, every other of a quick growing variety. Be sure that there is planty of space for lawns and gardens. Reserve large areas for football, hockey and parks. Earmark areas for Hindu temples, Mohammedan mosques and Christian churches".

The other projects envisaged by JN were the hydroelectric project and a major hotel. The Taj opened in Bombay in 1903. It was the first building to be lit by electricity in Bombay. But he did not have time to complete other projects during his life time but all took shape before a decade was over after his passing away. Jamsetji Tata died at Bad Nauheim in Germany on May 19, 1904, handing over the reines of his schemes into able hands.

In 1907 after arduous exploration a suitable site for the steel plant was found and the Tata Iron and Steel Company was floated at Sakchi in Bihar. In 1910, the Tata Hydro Electric Supply Company Ltd. was registered. In 1911, the Maharajah of Mysore laid the foundation of the Indian Institute of Science, Bangalore and later in the same year the first batch of students were admitted. In 1912, the first ingot rolled out of the Tata Steel Plant.

Writing about his father Dorab Tata stated "To my father acquisition of wealth was only a secondary object in life, it was always subordinate to the constant desire in his heart to improve the industrial and intellectual condition of the people of this country and the various enterprises which he from time to time undertook in his life-time had for their principal object the advancement of India in these important respects".

A young Englishman Norman Redford often used to go with JN on drives in his Victoria in the evenings. According to him "Never did I see Mr. Tata impatient, intolerant or critical of others' shortcomings". This is an important point of his characteristics to be noted as for many of us, the energy is frittened away pointing fingers at others, this was canalized into creative avenues. Concern for people was his in-born trait. Another contemporary of his said that looking at him (JN) you would not think you were looking at a seer, but he was one.

JN had studied and understood the problem of development and it was not empty rhetoric to be fired from the public platform but it was a deep commitment. According to him "*what advances a nation or community is not so much to prop up its weakest and most helpless members, as to lift up the best and most gifted so as to make them of the greatest service to the country*". By his legacy, his silent actions, and his few utterings, the posterity can only wonder how close they were to a 'rishi' of Upanishadic description. ☐

B. B. Baliga

WEATHER IN THE EARTH'S OUTER SPACE*

S. S. BARAL**

I feel highly honoured at the invitation extended to me by the Council of the Indian Science News Association to deliver the S. K. Mitra Memorial Lecture of 1989. I am extremely thankful to the President and Members of the Council for having given me this privilege. My association with Prof. Mitra was for 15 years. In this respect I am after Prof. Bhar (30 years), Prof. Rakshit (20 years) and Prof. M. K. Dasgupta (19 years).

The present age is variously termed as Atomic age, Electronic age, Computer age or Space age. I would like to choose a subject linked with space age, as I have worked for some time on problems of the Earth's upper Atmosphere. Space age dawned on 4th October 1957 when the first Russian Sputnik was orbited. Since then, the satellite era has rapidly passed through stages of wonder and curiosity and has now attained a state of indispensable technology for human civilization. "Space Weather" is intimately connected primarily with the utilization of space by manned and unmanned space vehicles and satellites. "Space Weather" also affects world wide telecommunications, Radio, TV, etc. "Space Weather" is a subject of active theoretical and experimental research on Solar-Terrestrial Relationships.

The other reason for selecting a 'Space' oriented subject is the occasion on which this lecture is to be delivered. It is to be delivered in honour of Prof. S. K. Mitra who was a strong advocate of space research in India : (1) Prof. Mitra's last publication was in July 1963, just about a month before his death and it was published in *Science and Culture* with the title "Physics of the Earth's outer space". (2) In 1960, Prof. Mitra delivered a series of lectures under the auspices of the Indian National Science Academy on the Evolution of space research in India, on Space Exploration by Rockets and Satellites and on Solar Terrestrial Relationships. (3) In the 1952 Edition of his "Upper Atmosphere" he concluded his book citing problems of Earth's Outer Space and laid stress on Space Research. (4) Russian Scientists engaged in space exploration have acknowledged utilization of upper atmospheric data from the Russian edition of Prof. Mitra's book published in 1955 for calculating the orbit of their Sputnik I which started the space age. (5) Prof. Mitra created the Ionosphere Field Station at Haringhata with an extensive land of more than 75 acres, with the ultimate aim of Creating a Centre of Advanced Studies on Radio and Space Physics in India. His aim was not fulfilled as the Field Station got dissolved in some wider Fields of Study. (6) He had always expressed till 1960, his great desire to publish a 3rd edition of his "Upper Atmosphere" with emphasis on Top-side Ionosphere, Protonosphere and Magnetosphere of the Earth and on the State of Current Knowledge on Solar Terrestrial Relationships. His desire was left unfulfilled. It may be mentioned that the UNESCO has declared an "International Space Year" to be observed early in the 1990's.

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* 2nd S. K. Mitra Memorial Lecture delivered on February 17, 1989 held under the auspices of the Indian Science News Association.

** Dharapara, Chandannagar, Hooghly-712 136.

I shall begin my talk with 'Weather in Earth's Outer Space' and its impact on the present state of our knowledge in various fields of Science and Technology. I shall conclude with my homage of respect to the Memory of Prof. S. K. Mitra.

Prof. Richard P. Feynman of California Institute of Technology was once giving a talk on the probable cause of the disaster of Space Shuttle "Challenger" killing six most capable astronauts of the U. S. A. He emphatically stated that a probable cause is our limited knowledge of the Weather of the outer space of the Earth. Another is failure of materials. But this is also ultimately related to our limited knowledge on properties of materials in the environment of the Earth's Outer Space.

Starting from Earth's surface, the Earth's atmosphere is divided into different regions upto a height of several thousand kilometers. The recommended nomenclature of these regions are : troposphere, stratosphere, mesosphere, ionosphere, thermosphere, protonosphere, magnetosphere. The classification has been explained in Fig. 1. The magnetosphere extends to about 10 Earth radii in the undisturbed condition. But since it is acted upon by the solar wind, the Sun-side of the magnetosphere is compressed, and the opposite side extends to some 100 earth radii (Fig. 2). When the Sun is very active, the magnetosphere tail extends to about a million kilometers. The equational ionosphere is characterised by Electrojet, Ion clouds and spread F ; the protonosphere and the magnetosphere are characteristed by the existence of Van Allen Radiation Belts : the Inner Belt consists of protons and near the equator it exists within altitude 1000-4000 km, the Outer Belt is mostly populated by electrons and near the

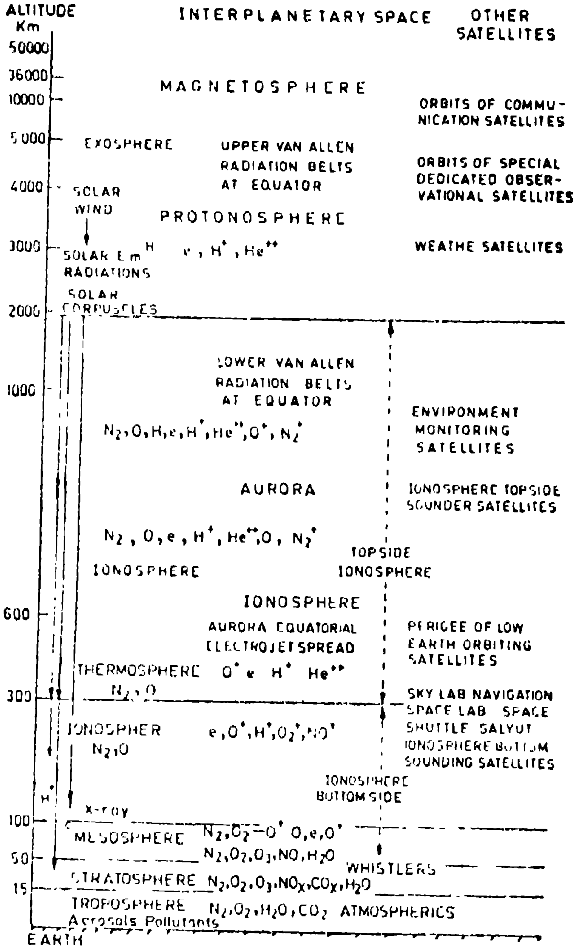
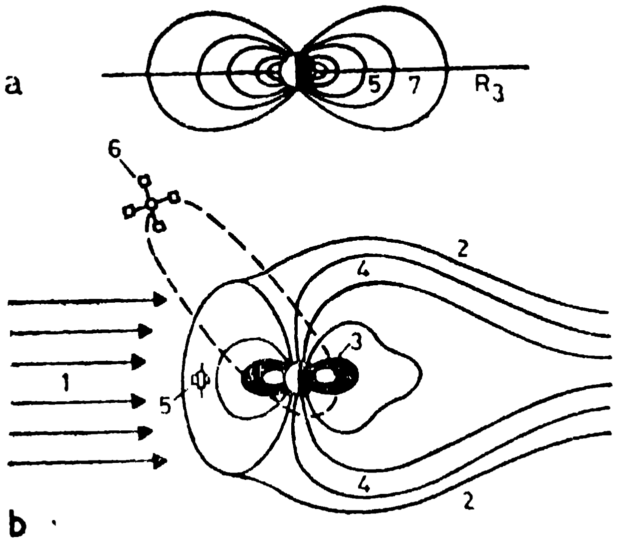

ALTITUDE Km
50000
36000
10000
5000
4000
3000
2000
1000
600
300
100
50
15
INTERPLANETARY SPACE
OTHER SATELLITES
MAGNETOSPHERE
ORBITS OF COMMUNICATION SATELLITES
EXOSPHERE
UPPER VAN ALLEN RADIATION BELTS AT EQUATOR
ORBITS OF SPECIAL DEDICATED OBSERVATIONAL SATELLITES
SOLAR WIND
PROTONOSPHERE
SOLAR Em RADIATIONS
H
e, H+, He++
WEATHE SATELLITES
SOLAR CORPUSCLES
LOWER VAN ALLEN RADIATION BELTS AT EQUATOR
N2, O, H, e, H+, He++, O+, N2+
ENVIRONMENT MONITORING SATELLITES
AURORA
IONOSPHERE TOPSIDE SOUNDER SATELLITES
N2, O, e, H+, He++, O, N2+
TOPSIDE IONOSPHERE
IONOSPHERE
IONOSPHERE
AURORA EQUATORIAL ELECTROJET SPREAD
PERIGEE OF LOW EARTH ORBITING SATELLITES
THERMOSPHERE O+ e H+ He++
N2, O
SKY LAB NAVIGATION SPACE LAB SPACE SHUTTLE SALYUT IONOSPHERE BOTTOM SOUNDING SATELLITES
IONOSPHER N2, O
e, O+, H+, O2+, NO+
IONOSPHERE BOTTOM SIDE
H+
X-ray
MESOSPHERE N2, O2—O+ O, e, O+
N2, O2, O3, NO, H2O
WHISTLERS
STRATOSPHERE N2, O2, O3, NOx, COx, H2O
TROPOSPHERE N2, O2, H2O, CO2 ATMOSPHERICS
Aerosols Pollutants
EARTH

Fig. 1



a : Earth's magnetic field in absence of solar wind

b : Effect of solar wind on Earth's magnetic field

1—Solar wind
2, 4—Earth's magnetic field
3—Radiation belts
5—Satellite prognoz

Fig. 2

equator extends from 10000 to 20000 km which stretches upto about 40000 km during high solar activity. Both the Radiation Belts extend upto about 70° latitude in both the Northern and the Southern hemispheres.

The Earth's atmosphere can cause aerodynamic forces to act on a satellite upto about 750 km. The atmospheric density at high altitudes varies considerably between day and night, summer and winter and high and low solar activity. The Sun and the Moon exert gravity forces that cause orbital changes as time passes. Solar radiation causes pressure at altitudes of 1500 km and above. Earth's magnetic field will reduce the spin rate of a satellite and alters its stability. Leakage in gas or liquid propellant also affects the performance of a satellite very seriously. The bottom-side of the ionosphere affects the Perigee of many useful satellites and it affects long distance short-wave radio communication ; the top-side of the ionosphere affects the Apogee of such satellites. The magnetosphere affects the spin and attitude of the communication satellites placed at "Clarke" orbit at an altitude of about 36000 km. The magnetosphere merges into Interplanetary space.

The bottom-side of the ionosphere from 50 km from ground upto a height of about 300 km is divided into distinct ionized regions D, E, F_1 and F_2 at heights of about 50, 100, 220 and 300 km during day time. At night D and F_1 disapper and a faint E region and a single F-region exist. The electron density in the lower half of the F_2-region during day and F-region at night has a semi-parabolic distribution with height with a maximum at about 300 km. From the top of 300 km to about 1500-2000 km, known as the top-side of the ionosphere, the electron density falls off exponentially with height (Fig. 3). Protons form a large part of the population of the upper part of the top-side ionosphere. This has been confirmed by rocket and satellite data and from incoherent radar studies. The International Reference Ionosphere (IRI) is based on the above picture of the ionosphere. The world morphology of F-region ionization shows a

Density at 2000 km from satellite data
6×10^{-18} gm/cm^3 in summer
4×10^{-14} gm/cm^3 in winter

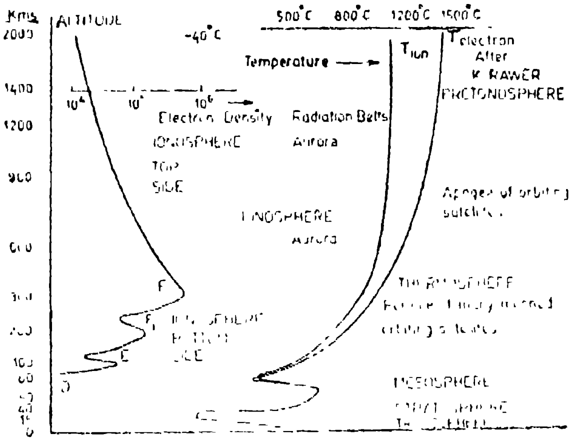


Fig. 3

strong geomagnetic control. This control has been found both in the electron and ion distributions of bottom and top-side ionosphere (Fig. 4).

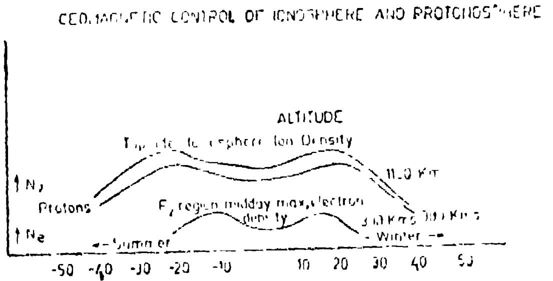


Fig. 4

The ionospheric ionization and the geomagnetic field are under strong solar control. This was revealed long ago by ground based experiments over long periods of time by a large number of observatories of the world, prior to the Space Age. In the Space Age, not only have the earlier results been confirmed, but new phenomena have also been detected in the Earth's Outer Space : Van Allen Belts, Solar wind, ion clouds, tidal effects, earth's gravity control, etc.

The sum total of the phenomena that occur in the Earth's upper atmosphere, in the ionosphere, in the magnetosphere and in the Earth's outer space where it merges with Interplanetary Space are collectively referred to as Weather in Earth's Outer Space. Space Weather is as important for an astronaut as ground weather is for the pilot of an aircraft or the Captain of a ship. For supersonic flight, weather in both the ground sector and the space sector are important. The same is also true for the space shuttles operating between ground and space. Manned space flight programme is especially concerned with solar activity, as lethal streams of energetic particles and radiations are sporadically expelled from the Sun when there appear Sunspots, solar flares, and other prominences in the Sun. Prof. Feynman has proved beyond doubt that insufficient knowledge of space weather led to the disaster of space shuttle challenger with six famous US astronauts. These precious lives were destroyed.

Space weather affects radio communication on earth, has strong effect on magnetic compass needle of the ships in oceans, can affect the memories of computers in space ships, can cause dangerous voltages in transformers in power lines and telephone lines and so on. In order to know in advance the weather in outer space, it is absolutely necessary to know the solar terrestrial relationship, details of the Sun's electromagnetic and corpuscular radiations, details of the Sun's rotation etc., for more than a solar cycle (11 years).

The Sun gives out electromagnetic radiations of many wave-lengths. Of particular interest are the m-cm waves, ultraviolet radiation, visible rays, X-rays, solar cosmic rays and γ-rays. Ultraviolet radiations and X-rays are responsible for ionospheric ionization. The Sun also shoots out electrons, protons, α-particles and ionized heavy atoms. The Sun has a 27-day period of rotation, the equatorial part rotating faster than the rest. The sun has an 11 year cycle of activity with dark spots (Sunspots) bright patches (flares), filaments, prominences, faculae, flocculi, bursts of u.h.f. radiation in the m-cm band—all the phenomena waxing and waning in number, size, magnitude and intensity. Some large Sunspots have also a 22 year recurrence period.

Disturbances in the Sun cause disturbances in the Earth's ionosphere, in Earth's magnetism, in Earth's magnetosphere. Strong disturbances are known as storms: ionospheric storms, magnetic storms. The solar particles and radiations are invading the Earth both during Quiet as well as Disturbed periods of the Sun. The stream pervades the whole solar system. It is known as "Solar Wind". The wind blows constantly at about 400 km/sec when the Sun is quiet. When the Sun is active, during high solar activity periods, the wind velocity increases by a factor of 8 to 10. The activity is associated with large flares and solar flares are associated with "bursts" of radiation in the m-cm wave band (particularly on 10.7 cm). It is found that solar flares are more accurate indicators of solar activity than Sunspots. When a flare occurs the electromagnetic radiations of the flare reach the Earth after 8 minutes, solar cosmic rays within one hour, solar corpuscular radiations within 20-40 hours. The flare produces sudden disturbances in the D and F regions of the ionosphere, disturbances in the magnetic field of the Earth and aurora, and as stated before, "bursts" of radiation in the m-cm band. During large flares called "flashes", the intensity of the m-cm wave band radiation increases by factors varying from 10^5 to 10^7. Flashes accompany large Sunspots. Solar wind, or the Sun's corpuscular radiation consisting of electrons, protons and α-particles has been identified by astronomers with the expanding solar corona. Planetary probes have detected solar wind throughout interplanetary space. The solar corona reaches the limits of the Earth's outer space. Instruments carried by rockets, planetary probes and satellites have substantially added to our knowledge of the Sun and solar radiation. New instruments on Earth, particularly solar radio telescopes and radar have likewise collected a large amount of data on solar effects observed on Earth during normal and abnormal solar activity. The "Radio Sun" is much larger than the "Optical Sun" and can be "Seen" through radio telescopes even during cloudy weather. The Earth's ionosphere protects us from lethal solar radiations emitted by the solar corona and the Sun's plasma of ions and electrons protects the Earth from dangerous radiations coming from the Sun's photosphere and chromosphere.

The solar and terrestrial data collected in space and in laboratories all over the Earth can be combined together to give valuable information on Space Weather. The total volume of data so collected is enormous. Only a high power computer can analyse the data if it is desired that space weather is to be predicted. At present, earth bound weather data in the troposphere are handled by computers to predict ground weather. Prediction of weather in outer space will be of great value to determine accurately the altitude of a satellite and to control the same, to know its drag and estimate its life in space and to correct the orbit if necessary.

TABLE 1 : Some Relevant Satellite Data

			ALTITUDE kms
	Number of Satellite orbited during 1957→1, 1958→2, 1959—1970→900, 1960—1980→2500, 1960—1987→5000 Average Life 90 days to 10 Years.	Heliosonde	100000
ALTITUDE kms			
1500			90000
1200	Environment monitoring service Oceanographic studies		
		Prognoz	60000
900	Sputnik I apogee on 4-10-57.		50000
	Topside ionosphere experiment Navigation, Sun synchronous for geodesy, hydrology etc.		40000
600	Earth Resources	Communication	36000
	Indian Low Earth	(Over crowded)	30000
	Salyut orbiting station, Skylab, Space Lab, European Space Lab, Space Lab for Material and Chemical processing, bioscience, Solar astronomy, Space Shuttle.		20000
300	Sputnik I Perigee		
200	Alouette, Explorer, Salyut, Atmospheric etc.	Meteor, Nimbus	10000
150		Weather Surveillance	
GROUND			GROUND

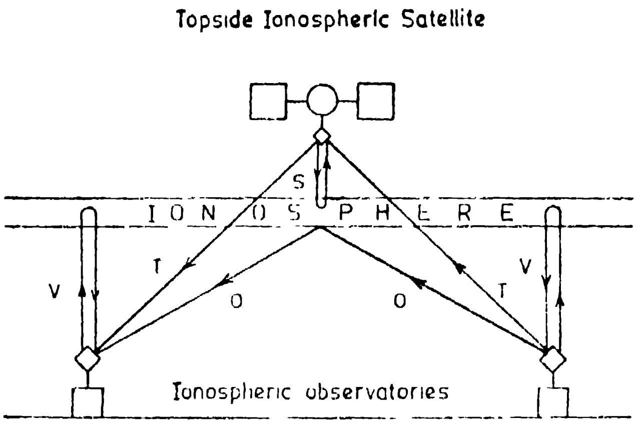
During the eighties, the number of satellites of various life span, manned and unmanned space ships, dedicated satellites and space ships for scientific research in geodesy, geophysics, hydrology, oceanography, telecommunications, astronomy, astrophysics, physics, chemistry, metallurgy, material science, biology and life sciences have exceeded 600, making the total number of satellite sent up during 1957-87 as 5000 (Table 1). But their life span was limited to maximum of 10 years from a minimum of a few days. Obviously, the majority of such satellites and space ships were sent by USA, USSR, UK, European Space Agency, Japan, West Germany and France, India and Indonesia have entered space age only in the seventies. Our understanding of space has been enriched by experiments carriedout during IGY, IQSY and subsequent years. Many more dedicated space ships and skylabs will be orbited during the International Space Year in the early nineties.

Detailed characteristics of the solar wind are not yet fully known. Solar wind produces arrora, magnetic storms, perturbations in Earth's magnetism and Ionosphere, affect the

Van Allen Radiation belts which release streams of electrons and protons during solar disturbances, exert influences on even living beings, particularly the astronauts, produce defects in cables and transformars. Operation of space-shuttles, space laboratories, skylabs marathon stay in space, rendez-vous in space and recent space endeavours of USSR will all be benefited from intensive studies of Weather in outer space and from ways of distinguishing between *good* and *bad* space weather.

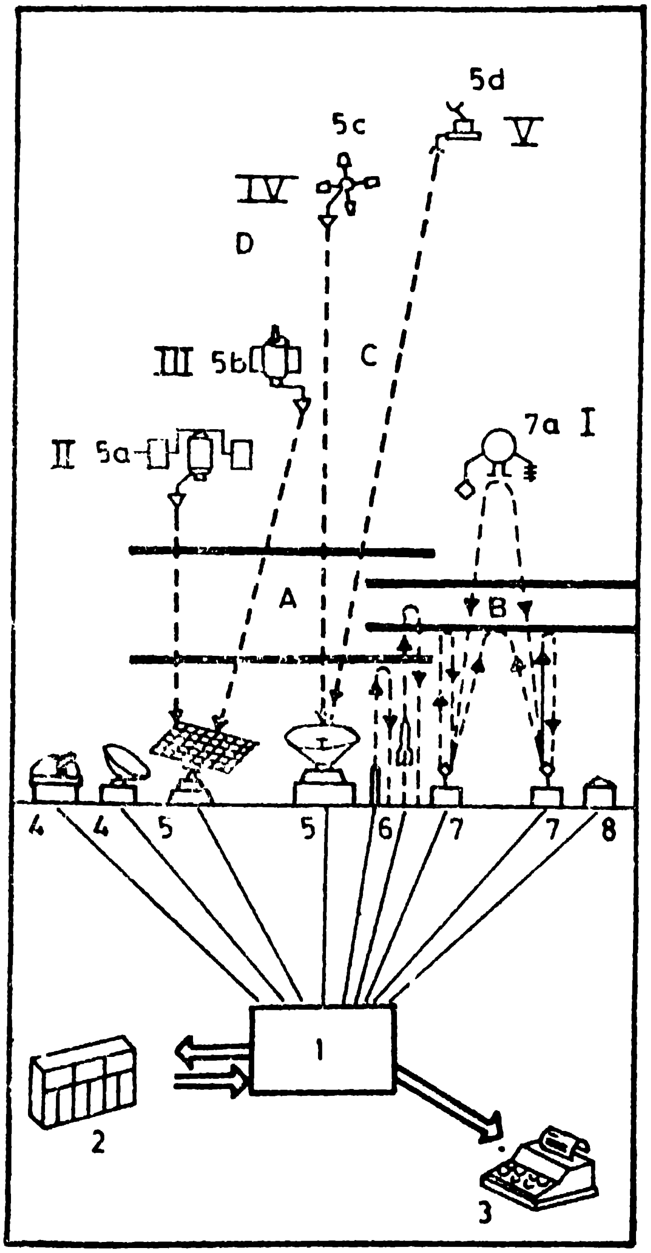
To keep a watch on space weather, a harmonious combination of ground and space based observations is necessary. Ground base observations will use optical telescopes, spectro-heliometers, radio telescope, radar and both vertical and oblique ionosonde, magnetic recording instruments, reception centres for signals from space, space telescope etc. in as many centres and suitable sites as possible. There must be arrangement for computerized communication via "dedicated" communication satellites in Clarke orbit with strictly maintained spin and attitude control. The space centre will consist of dedicated (i) Ionosphere satellites with arrangements for oblique and vertical incidence sounding and receiving ground signals, combination of ground and space sector will provide important supplementary data for regions above oceans, deserts, inaccessible mountains and forests and polar caps—which are unsuitable for ground based observations, (ii) Nimbus Meteor or Weather series satellites at altitudes of several thousand kilometers for monitoring proton stream and other energetic particles and solar cosmic rays, (iii) Space lab or skylab satellites at about a thousand kilometer altitude fitted with optical telescopes, spectrometer, spectro-heliometer for scanning the ultraviolet and visible regions of the Sun and recording solar prominences detectors for X-rays and γ-rays, (iv) Russian Prognoz type satellites for monitoring solar wind in the fringe of earth's magnetosphere and Interplanetary Magnetic Field (IMF), (v) a Heliosonde satellite at about 100000 km altitude for going round the Sun in Earth-orbit (rather than round the Earth) for monitoring the region of space occulted by the Earth. This may provide early warming of serious solar disturbances, as the Sun rotates on its axis. Many active regions survive for many days. This satellite will also provide warning of sudden change in IMF. Owing to Sun's rotation the IMF system outstrips the Earth's movement along the ecliptic. When the Earth crosses the boundaries of such sectors, the space weather is affected. This will supplement observations taken by dedicated geostationary satellites, (vi) Probing equipment with pulsed laser which can be used to study and monitor the bottom-side of the Ionosphere and below (vii) Regular measurements by manned and unmanned spacecrafts at 200-400 km altitude (such as the Skylab, Spacelab, Salyut series of satellites or the French Alouette series or U. S. Explorer series) of upper atmospheric constituents in that region, including remote sensing laser beams, can be arranged to supplement ground based laser and radar observatories for our understanding of the region between 180-200 km altitudes.

All the data collected as above can be communicated and inter-communicated between Earth and Space, analysed and results communicated to User Centres via Telecommunication Channels through powerful computer systems. Recording, deciphering, storing and using the processed data to issue telegrams, to compose press reports etc. for forecasting Space Weather through a service (Fig. 5a & Fig. 5b) akin to



S—Vertical sounding from satellite
V—Vertical sounding from ground
O—Oblique sounding from ground
T—Transionospheric sounding

Fig. 5a



I—Ionospheric satellite
II—Meteor or Weather or Nimbus satellite
III—Geostationary satellite
IV—Prognoz satellite
V—Heliosonde satellite
A—Upper Atmosphere ; B—Ionosphere
1—Forecasting centre with supercomputer
2—Data Bank
3—Users
4, 4—Optical and Radio observation centres for the Sun
5, 5—Reception of satellite data
6—Laser ranging centre to study middle atmosphere upto 80-100 km
7, 7—Ionosphere stations
8—Magnetic observatories

Fig. 5b. Integrated solar and terrestrial data collecting and disseminating centre for space weather watch.

Space weather affects life, drag, attitude of satellites.

Solar wind affects materials and life of astronauts, passengers in supersonic aircraft.

Space weather is as fickle as ground weather : no two days are alike.

Space weather is studied by (1) satellites ; (2) ground based ionosonde (vertical and oblique) ; (3) ground based observations of solar radio wave emission in the m-cm wave band ; (4) ground based magnetic measurements ; (5) detection on sudden ionospheric and sudden magnetic disturbances etc. Most of the experimental satellites have Perigees in the range 200-600 km and Apogees in the range 400-1600 km.

URSIGRAMS. Table 1 and Table 2 are records of some outer space activities of advanced countries of the world as also of India.

TABLE 2 : ISRO Satellites

Aryya Bhata	1975	Design	Life 1	year
Bhaskara I	1979		,,	,,
Rohini I	1980	Perigee 200-600	0.25	Year
		Apogee 600-1600	,,	,,
Rohini D I	1981	,,	,,	,,
Apple	1981	Geo-synchronous 36000 km	2.0	,,
Bhaskara II	1981	,,	1.0	,,
Rohini D II	1983	Perigee 200-600		
		Apogee 600-1600	0.25	,,
IRSIA	1984	Sun-synchronous		
		Land survey 900 km	3 0	,,
SROSS	1985	Perigee 200-600		
		Apogee 600-1600 km	0.25	,,
INSAT I A, B	On going	Communication		
INSAT II	projects	Meteorology	5 0	,,

Other projects : IRS, SROSS, PSLV, ASLV, etc.
IRS—Indian Remote Sensing
SROSS—Stretched Rohini Series of Satellites

Application : Telecommunication, TV, Radio, Remote Sensing, Meteorology
Data collection and Processing and Dissemination,
Sensor development

Only USA and USSR have sent manned Space ships

This is all I wanted to say on "Weather in the Earth's outer Space". I now seek your permission to place before you my reminiscences of Prof. Mitra, his guidance and his inspirations and to offer my homage of respects to him.

I started my life in Science College in 1941 as a Technician in the Cyclotron Laboratory of Prof. M. N. Saha. I did some work on the design of the magnetic field when I was asked to work in the High frequency Power Oscillator. I was so frightened that I approached Prof. Saha to express my inability. I also said that Mr. Bindhumadhab Banerjee is the fittest person to take up this challenging work. The challenge was that the system had to be evacuated, the vacuum maintained properly and then the Oscillator to be operated with high voltage and high current. Prof. Saha was very kind to me. He read the panic on my face. He called Prof. H. Rakshit in his room. After some discussion, I felt relieved when Dr. Rakshit also said that Mr. Banerjee was the most suitable person to face this challenging job. So I came to Prof. Mitra's laboratory and Mr. Bindhumadhab Banerjee joined Prof. Saha's laboratory at the end of 1942. There was no transmitting license because of the War. But I was asked to set-up a pulsed oscillator in order to get initial training. Simultaneously I had to set up an apparatus for Nitrogen afterglow with J. S. Chatterjee.

In 1944, the transmitting license was restored at the intervention of Sir E. V. Appleton. In the same year Prof. Saha appointed me as Demonstrator of the Physics Department and asked me to work in Prof. Mitra's Laboratory. Due to Prof. Saha's magnanimity, I got a better pay. Next year, in 1945 a research scheme on Ionospheric Investigations was sanctioned by C. S. I. R. when Mr. S. N. Ghosh, Mr. S. N. Mitra and myself were taken in as Research Assistants. Of-course, my work as Demonstrator continued upto 1949. I got involved in the work of the Ionosphere transmitter receiver and associated instruments ; I learnt a lot. Also, while assisting Prof. Mitra in the compilation of his treatise on Upper Atmosphere in 1947 and revising the same for the Second Edition in 1952, my association with Prof. Mitra deepened. I had the opportunity of knowing him most intimately, of getting his advice and blessing without asking for any even, and of receiving his instructions and inspirations in my academic as well as domestic life. I stayed with him till the end of 1956.

From 1952 to 1956 I had to go to Haringhata in the company of A. K. Saha. During my stay in Prof. Mitra's laboratory I had the opportunity of being in the association of illustrious scientists like S. N. Ghosh, S. N. Mitra, M. K. Dasgupta, A. P. Mitra, B. R. Nag, M. R. Kundu, A. N. Daw, P. Banerjee and others. I left the Institute of Radio Physics and Electronics in December 1956 and went to seek my fate in B. E. College.

While in B. E. College, I often visited the Indian Botanic Garden. There I watched with awe the famous big Banyan tree. The tree reminded me of Prof. Mitra.

Prof. Mitra rose high—not as a tall palm or coconut tree—but as the big Banyan tree under which I sat very often. Like the Banyan tree, Prof. Mitra spread roots all around him through his capable students far and near. The roots were sources of fresh trees and fresh roots again. The main root of the Mitra-Banyan may wither away, with age, but the tree will live long through the "Student-roots" like Mitras, Dasguptas, Nags etc.

Amongst Prof. Mitra's students there are about 14 Fellows of the National Academy of Sciences India, one Fellow of the Royal Society, London. His students A. P. Mitra, B. R. Nag, M. R. Kundu, Sanjit K. Mitra have written books of international importance and world-wide circulation. Successful and popular textbook writers are Ghosh, Dev, Daw, Basu and Chatterjee.

I thank you all for your tolerance and for your patient hearing. I thank again the President and Members of the Indian Science News Association for kindly inviting me to deliver a lecture this afternoon.

I have appended a list of achievements and fields of interest of Prof. S. K. Mitra (Appendix-I). ☐

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[8]*Progress in Radio Science*, 1985 & 1986.

Appendix—I

Prof. Mitra was working on Spectroscopic standards in France under the eminent Professor Charles Fabry, when he was invited by Sir Asutosh Mookerjee to join Science College, Calcutta. Earlier, he had received inspirations from the works of Sir J. C. Bose on u.h.f. and micro-waves. In France, he was in touch with Prof. Gutton who was working in vacuum tube oscillators. In England, he was in contact with Sir Oliver Lodge who was working on solid state detectors of radio waves. When Prof. Mitra joined Science College in 1923, he first worked on Atmospheric Electricity and, then in 1925, he established the Wireless laboratory for teaching and research on the generation and propagation of radio waves. He started with spark gap oscillators and then used thermionic vacuum tubes. He used the Barkhausen oscillator for u.h.f. and power triodes for medium-waves. With medium-waves he started the Radio Broadcasting Station in Science College which was the first in Calcutta. His associates were H. Rakshit, Atul Ray and Biren Bhadra. He used medium-wave oscillations for researches on Ionosphere first by Appleton and Barnett's method and subsequently by Breit and Tuve's method. This was the beginning of Ionospheric research in India. In 1932-33, Prof. Mitra collaborated in the International Polar Year Observations. His work on upper atmosphere in general, and ionosphere in particular, gathered momentum with his associates Syam, Bhar and S. P. Ghosh. During the 2nd World War, the transmitting license was withdrawn and Prof. Mitra directed researches on Atmospherics, Light of the Night Sky, Nitrogen afterglow, Auroral spectrum, Light effect apart from theoretical studies on upper atmosphere. The transmitting license was restored at the intervention of Sir E. V. Appleton. In 1942 Prof. Mitra created the Radio Research Committee under the CSIR and directed research on industrial electronics and indigenous methods of constructing microphones, loudspeakers, low cost radio receivers etc. He also directed work on directional characteristics of microphones and loudspeakers in an echoic chamber designed under his guidance. Other fields of research under Prof. Mitra included generation and properties of ultrasonics and techniques for picture transmission. In 1947, Prof. Mitra published his treatise on Upper Atmosphere which was revised in the Second edition in 1952. In 1949, Prof. Mitra created the Institute of Radio Physics and Electronics and the Ionospheric Field Station. Both were the first of their kinds in India. In 1954, he attended the URSI meeting as Chairman. In 1956-57, he participated in the IGY observations. □

OBITUARY

USHA NATH CHATTERJI

Prof. Usha Nath Chatterji breathed his last on October 3, 1988 at Allahabad after a prolonged illness. He was born at Allahabad on January 1, 1907 in a chaste Brahmin family of Bengal. He had his complete education at Allahabad. In the passing away of Prof. Chatterji, the Indian Botany has lost a renowned botanist, a gifted teacher and a friend to everybody with whom he came in contact. Besides being an academician of repute, he was an able administrator. He remained a bachelor all his life. His Ph. D. thesis entitled "Studies on the effects of definite doses of alcohol on respiration of green leaves" and then his D. Sc. thesis entitled "Physiological studies in some intermediate steps in plant respiration", was highly spoken of by his examiners, Prof. V. H. Blackman, Prof. A. S. Appleman and Prof. P. Parija. He taught at Meerut College, Meerut and Agra College, Agra for brief periods. He worked very successfully at ICAR for over thirteen years as editor of publications. I had known Prof. Chatterji from 1959, when he joined as an Associate Professor of Botany at the newly-started Botany Department of Gorakhpur University. He joined the newly-started University of Jodhpur in 1963, from where he retired in 1966, and fell seriously ill due to some intestinal disorder, causing a break in his botanical career.

Prof. Chatterji was a student of Prof. Shri Ranjan, a renowned Plant Physiologist at the University of Allahabad. He enjoyed great reputation as a research scientist. He established a school of 'Ecophysiology of Seed Germination' at the University of Jodhpur, besides establishing tissue culture and biochemistry laboratories. He was Sectional President of Agricultural Sciences of Indian Science Congress held at Bombay (1969), President of Indian Society of Plant Physiology (1975) and President of Biological Section of the National Academy of Sciences (1966). He has been fellow of various societies both in India and abroad. He was a member of Indian PEN which is an international organization of Poets, Essayists and Novelists. A number of his students occupy seats of learning at various Universities/Institutions. His dedicated contribution to the cause of botany will be long remembered by the contemporary and future generations of Plant Scientists. ☐

David N. Sen

Notes and news

Azolla allows farmers to grow their own fertilizer

In the 11th Century, farmers in the Kingdom of Dai Viet grew the tiny water fern azolla in their rice fields. They did not know about nitrogen, the most critical requirement for plant growth—but they knew the fern made their rice grow better. During the 14th Century, farmers in the Kingdom of Cathay grew and sold the plant as feed for pigs and ducks. For hundreds of years, the descendants of those ancient Vietnamese and Chinese farmers used azolla to fertilize their crops and feed their animals. Today, cultivation is rapidly spreading to other countries, notably the Philippines.

"Any rice plant, modern or traditional, requires 1 kilogram of nitrogen to produce 15 to 20 kg of grain," says Iwao Watanabe, head of the Soil Microbiology Department of the International Rice Research Institute (IRRI). "Most tropical soils absorb enough nitrogen naturally to grow about 1 or 1.5 tons of rice per year. To increase yields above that, nitrogen must be supplied."

In the 1960s, petroleum-based fertilizers were the most economical ways to add nitrogen to the soil, Whatanabe says. "But fertilizers are costly, and we are increasingly aware of environmental pollution caused by improper fertilizer use." The air around us is 80% nitrogen. *Anabaena azollae*, a blue-green alga that lives in the cavities of azolla leaves can fix or draw nitrogen from the air. Azolla floats on the water between the rice plants. When azolla dies and is incorporated into the soil, decomposition frees the nitrogen. Farmers who grow azolla can grow their own fertilizer. For only 3 hours labor per hectare, a farmer can grow enough azolla to increase yields by 1.5 tons per hectare.

"Azolla growth does not interfere with normal rice cultivation." Watanabe says. "In fact, it helps control weeds and improves soil texture." "Rice fields where azolla is grown should have good water control," Watanabe explains. "To thrive, azolla needs high soil phosphorus, temperatures no higher than 35 C, and a long wet season." Azolla is also susceptible to fungus and insect attacks during the hot and humid seasons.

The Philippines set up a National Azolla Action Program (NAAP) in 1983 to integrate azolla studies and propagation projects of the Department of Agriculture, IRRI, and the Philippine Council for Agriculture, Forestry, and Natural Resources Research and Development. "The NAAP triggered a big leap in azolla research in the Philippines," says Dames Callo, a member of the NAAP operations team based at the University of the Philippines at Los Banos (UPLB). IRRI aud NAAP have started a project to breed new azolla strains that are resistant to insects, and that grow better in soils with low phosphorus.

In northern Vietnam, azolla multiplication centers select, maintain, and multiply azolla for farm cooperatives in the Red River Delta. China founded a National Azolla Research Centre in 1984. Chinese scientists found that swine, geese, and fish fed azolla as a supplement gained about 20% more weight than those fed only concentrated feed. Azolla has about 25% more crude protein than other green forage crops such as sweet potato shoot, water hyacinth, and water lettuce. It is also rich in crude fat, calcium, and phosphorus.

IRRI started azolla research in 1975. It now maintains 420 strains—the world's largest collection of azolla germplasm. These strains are sent worldwide for testing by national programs. The collection will soon be housed in a Biofertilizer Building being constructed at IRRI with funds from Japan and Italy. [ ]

IRRI News

Revamping millets research in Tamil Nadu Agricultural University --An appraisal

Millets form a group of coarse grains capable of thriving adverse seasonal conditions. They occupy an area of 15 lakh hectares (ha) which is 21% of gross cropped area in Tamil Nadu. A quantum leap in the productivity of millet crops viz., sorghum, pearl millet, finger millet and maize, was witnessed in the recent years following the development of hybrids, composites and appropriate production technologies, but still the average yield/ha has not been increased substantially. The average yield is very low (1.2 tonnes/ha) compared to the potential yield of 4.5 tonnes/ha.

In order to improve the present condition, the millet scientists from all over the state attended a workshop at the main campus of Tamil Nadu Agricultural University at Coimbatore during March 7-8, 1989 and deliberated over the future research strategies required and thrust areas to be tackled in the coming years.

Presiding over the Workshop, S. Jayaraj, Vice-Chancellor, Tamil Nadu Agricultural University, emphasised that millets along with tree crops is the best combination to combat the drought conditions as well to overcome the fodder shortage for animals. He called upon the scientists to promote millet production in the potential belts to match the poultry production and the Animal Nutritionists to identify nutritive fodders. "Processed food items from millets" is the mandate fixed for Tamil Nadu Agricultural University Food Scientists, enabling the millet farmers to get additional farm income.

In his opinion, the choice of millet crop, specific varieties and cropping system should be based on the rainfall pattern specific to the region. Disclosing the massive fabrication of farm machinery in the University workshops for supply to all the Regional Research Stations and Krishi Vigyan Kendras in Tamil Nadu, the Vice-Chancellor categorically stated that the appropriate farm implements and machinery should form the integral part of dryland technology in Tamil Nadu. Taking econometrics to the practical ladder of predicting the probabilities of dry spell, monsoon, soil moisture, pest and disease outbreaks, yield predictions and many more farm related aspects, the computerisation of farm research data is now well within the reach of Tamil Nadu Agricultural University which has got a well equipped computer centre. Jayaraj called upon the participating scientists to develop appropriate models to be test verified in different agro-climatic conditions in the state in farmers fields through on-farm trials.

Outlining the millet scenerio of Tamil Nadu, S. Chelliah, Director of Research, Tamil Nadu Agricultural University, emphasised the need for intensive researches on intercropping giving region specific recommendations which inturn give additional income to the farmers. He advocated exotic breeding programmes in cholam and cumbu.

Based on the two-day deliberations, the following thrust areas in millet research have been identified for implementation in different parts of Tamil Nadu :

1. Computerisation of research data available on all major millet crops and development of prediction models for rainfall and pest and disease outbreaks. Integrated watershed management in low rainfall areas in Tamil Nadu.

2. Catalogueing of the available male sterile lines in sorghum (cholam), maize and pearl mallet (cumbu) for evolving high yielding and pest and disease resistant hybrids.

3. Evolution of sweet sorghum varieties suitable for production of industrial ethanol (alcohol).

4. Breeding drought-tolerant and high-yielding varieties Makkattai cholam suited to Tiruchi and Pudukottai district, Periamanjal cholam for Coimbatore and Periyar districts and Thalaivirichan cholam for North Arcot and Dharmapuri districts under rainfed conditions.

5. Pearl millet (cumbu) hybrids and varieties suitable for intercropping in groundnut.

6. Evolution of high-yielding and drought-tolerant minor millets like Tenai, Panivaragu, Samai and Kudiraivali for the plains and hilly tribal areas.

7. Study on the performance of millets in soils irrigated with leather-tannery effluents in Palar Basin in North Arcot district and ameliorative measures to mitigate the ill-effects.

8. Efficiency of bio-fertilizers in the integrated nutrient management, on the incidence of the diseases and pests of millets and ability to withstand drought.

9. Tissue-culture studies to evolve better varieties to combat blast disease in Ragi and downy mildew in cumbu.

The past researches in millet crops have been thoroughly analysed by this scientists forum and new orientation to revamp the millet research strategies was given. Such forums form a basis for self analysis as well as understanding the views of scientists of all disciplines. ☐

Indira Gandhi Prize for Popularization of Science

Nominations are invited for the award of Indira Gandhi Prize for Popularization of Science for the year 1990.

The prize will be awarded for outstanding work by an individual for the popularization of science in any Indian language, including English. The nominee must have had a distinguished career as a writer, editor, journalist, lecturer, radio or television programme director, film producer, science photographer or as an illustrator, which has enabled him/her to interpret science (including medicine), research and technology to the public. He/She should have a knowledge of the role of science, technology and research in the enrichment of cultural heritage and in solution of problems of humanity. Work already recognized for any other award will not be accepted.

The prize is open to any Indian national residing in the country and will carry Rs. 10,000/- in cash and a bronze medal. The prize winner will be expected to deliver a lecture at the venue to be fixed by the Academy.

Nominations for the award of prize may be made by the Fellows of INSA, Vice-Chancellors, Deans, Principals, Directors of leading scientific institutions and National Laboratories and Editors of Indian Science Journals in the prescribed proforma which will be supplied on request.

The Nomination form duly completed in all respects may be sent so as to reach the Executive Secretary, Indian National Science Academy, Bahadur Shah Zafar Marg, New Delhi-110002 latest by July 15, 1989 indicating on the envelope "Nomination for Indira Gandhi Prize for Popularization of Science." ☐

INSA Medal for Young Scientists—1990

Instituted by the Indian National Science Academy in 1974 the Medal is awarded annually in recognition of outstanding work of scientists below the age of 32 (as reckoned on 31st December preceding the year of award). Only those born on or after January 1, 1958 are eligible for consideration in 1990. The work done in India by the nominee will be taken into consideration for the award.

The awardee is presented a medal and a cash award of Rs. 5,000/-. In addition, the recipient is considered for a research grant by the Academy not exceeding Rs. 20,000/- per year, including stipend for a JRF for a period of three years for continuing research work, provided the research proposal is considered worthy of such support. Preferential consideration may be given under partial travel grant scheme for attending international conferences.

Nominations for the awards for 1990 may be made by Fellows of the Academy, established scientific societies of all India character, University faculties and departments, or the research institutions.

The last date for the receipt of nominations in the Academy is November 15, 1989.

Nomination Proforma can be obtained from the Indian National Science Academy, Bahadur Shah Zafar Marg, New Delhi-110002 by sending a self addressed envelope of 28 cm × 12 cm size. ☐

Announcement for Awards

Professor Hira Lal Chakravarty Awards : Applications in prescribed forms are invited from Indian Scientists, below 40 years of age on December 31, 1988, with Ph. D. degree, having outstanding publications in any branch of Botany—pure or applied—by July 15, 1989. There are two awards ; each carries a cash amount of Rs. 4,000/- and a certificate.

Pran Vohra Award : This award is meant for scientists below 35 years of age on December 31, 1988, with Ph. D. degree in Agricultural Sciences from any University or Institution in India, having made significant research contribution in any branch of Agricultural Sciences. Only research done in India will be considered for the award. The award carries a cash amount of Rs. 4,000/- and a certificate and the awardee will be required to deliver a lecture on the topic of his/her excellence during Annual Seassion of the Indian Science Congress Association in the Section of Agricultural Sciences. Last date of submitting application is July 31, 1989.

For prescribed application forms and necessary information, please write to the Indian Science Congress Association, 14, Dr. Biresh Guha Street, Calcutta-700 017. ☐

Institution of Chemists (India) : Associateship Examination, 1990

The Fortieth Associateship Examination of the Institution of Chemists (India) will be held in November, 1990. The last date for Registration is 30th November, 1989. The

Examination in Applied Analytical Chemistry is divided into the following eleven sections and each candidate will be examined in two of them according to his choice as approved by the Council, in addition to General Chemistry including Organic, Inorganic, Physical and Applied Analytical Chemistry : (1) Analysis of Minerals, Silicates, Ores and Alloys ; (2) Analysis of Drugs and Pharmaceuticals ; (3) Analysis of Foods ; (4) Analysis of Water and Sewage ; (5) Biochemical Analysis ; (6) Analysis of Oils, Fats and Soaps ; (7) Fuel and Gas Analysis ; (8) Analysis of Soils and Fertilisers ; (9) Analysis Connected with Forensic Chemistry ; (10) Analysis connected with Leather Chemistry ; (11) Analysis Connected with Textile Chemistry The Examination is recognised by the Government of India as equivalent to M.Sc. in Chemistry for purposes of recruitment of Chemists. Further enquiries regarding this and for Membership may be made to the Honorary Secretary, Institution of Chemists (India), 11/4, Dr. Biresh Guha Road, Calcutta-700 017. ☐

BOOK REVIEWS

Introductory Quantum Mechanics—By S. N. Ghoshal, Published by Calcutta Book House, 1/1, Bankim Chatterjee Street, Calcutta-700 073. Price Rs. 45/-.

The present book is written according to the B. Sc. (Hons.) syllabus of the Indian Universities. In the book there are three chapters on Foundation of Quantum Theory, Wave particle Duality, Nature of Matter waves, uncertainty relations which are devoted to the physics behind the emergence of quantum theory, in its historical perspective, wave particle duality, Heisenberg's uncertainty principle, Bohr's principle of complimentarity, applicability of classical and quantum concepts, principle of superposition etc.

The last three chapters are devoted to quantum mechanics, Schrodinger wave equation its solution in one and three dimensional cases. Each chapter is elucidated with illustrative examples, problems and suggested questions. These are helpful to the freshers who are for the first time are introduced to the subject.

There are a number of text books in the market on quantum mechanics, some of which are equally introductory. The present book is comparable to them and more in the sense that it covers the syllabus of the Indian Universities.

The author is a renowned physicist, a celebrated and popular teacher in physics devoting most of his years in well known academic institutes. The present book based on his lecture notes will be valuable assistance for the undergraduate students of our Universities.

The book may also be recommended as an introductory course before entering into an advanced one in any discipline where the knowledge of an advanced quantum mechanics is needed.

The printing, drawings and the overall editing are satisfactory and the price in comparison is reasonable for the students for whom the book is meant. ☐

S. B. Karmohapatro

Science Corner

Articles published in this section are for students and general readers for understanding science in the perspective of its fundamentals. We invite science teachers and scientists for contributing articles to this section. Also we shall appreciate comments from our readers on the articles published in this section.—*Ed.*

ETHNOMEDICINAL STUDIES OF THE HIMALAYAN FLORA

G. K. SHARMA*

The Himalayas have played a primordial, nay, a plethoric role in the evolution of cultural psyche of mankind. They are a repository of some of the most ancient civilizations of man. The Himalayan flora has contributed greatly to the pharmacopoeias of the world. However, it is felt that this treasure-trove has missed a systematic and comprehensive investigation and hence a plea for its thorough analysis with a commitment to its preservation and propagation, and the maintenance of ecological balance of the precious but fragile Himalayan ecosystem, which seems to be threatened in view of its reckless exploitation for transient gains.

"Now we shall discourse on the recipes and modes of using elixirs and rejuvenators of the human organism which will make it invulnerable to the inroads of any disease or of decay....". Such claims are quite known about the indigenous Ayurvedic system of medicine of India, known for relying upon herbs of the Himalayas as described in the *Susrita* and many other publications of the Indian subcontinent. The Himalayan flora is shrouded in the mysteries of the East and the importance of deciphering the code of this enigmatic treasure trove is beginning to be realized among the scientific community in view of the medicinal potentialities of the plants of this ancient area. The entire gamut of Indian literature

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of the Himalayas beginning with the remote antiquity of the arrival of the Aryans about 5-6,000 years ago to the present day is full of the references where plants of this great mountain range have been used for medicinal purposes. The indigenous Ayurvedic system and the subsequent Unani system are known to rely on herbs of the area and are practiced in the Indian subcontinent. In the great epic *Ramayana*, there is a distinct reference to a wonder drug found in a specific sector of the Himalayan range and this herb was ordered by Lord Rama to rejuvenate his dying brother. The *Vedas*, the pillars of pride and cultural achievements of the Indians, are a glowing testimony to this fact. The *Rig Veda* has been cited as one of the earliest books of mankind, dealing with plant utilization for medicinal purposes. The *Susrita* refers to numerous plant species of the Himalaya used in the Ayurvedic medicine today.

Rauvolffia, *Vinca*, *Cannabis*, and *Arisaema* lead the long list of plants of this area known to and used in medicine today. Their worldwide use indicates the significance of these taxa growing in some of the remotest corners of the world. Many more are in use in the remotest hamlets, sparsely populated villages atop the mountain cliffs and the crude pharmaceutical facilities of the area. Local medicine men, holy ascetics and isolated human populations of remote sites of the Himalayas are some of the sources where additional information on the medicinal uses of plants seems to be hidden and, hence, must be brought into the open so that the biodynamics of the active principles can be studied for their potential uses in medicine, especially in the treatment of cancer, AIDS and other ailments.

In the Himalaya, collecting plants of medicinal value, gathering information on the uses of the plants among the local human populations of this remote area and visiting the monasteries and shrines to locate and review the fragments of ancient literature known to contain references on the medicinal values of these plants is a must. The plants collected in the field must be analyzed for their active principles.

The Himalaya are known for medicinal plants in the scriptures and various other manuscripts of the area. Scholarly critiques of *The Rig Veda* and the *Ramayana* emphasize the great importance of the medicinal properties of the plants in many parts of the Himalaya. An intermingling of Indian and Tibetan/Chinese cultures in the area have produced pockets of populations in the Himalayan arc (which extends from Afghanistan to Burma) where local herbs of these mountains have been used for centuries for their therapeutic properties. It is only in the last decade or so that sophisticated tools of modern science have been used to monitor and confirm the age-old medical practices of the peoples of the area. Buddhist lamas or monks of India and Tibet with their austere ways and Indian Brahmins with their known airs of intellectual superiority still exhibit discrete reluctance to divulge their so-called secret combination of herbs for various ailments. Their devotees, imbued with blind faith in the magical or spiritual powers of these recluses of isolated monasteries and hamlets, are the prime beneficiaries of this ancient practice of utilizing the rare and unique flora of the Himalaya for its healing properties.

Furthermore, the Himalayan area is facing a constant threat from the onslaught of growing human populations. This fragile ecosystem which was and still is romanticized by poets, ascetics, and intellectuals is liable to lose its delicate equilibrium and pristine beauty of its flora and fauna if this threat is not checked. If this threat were to become a reality, it will be a colossal loss to humanity and hence the flora known for its much glorified potentialities will vanish. Deforestation in the area has been going on for decades, especially in the area under discussion. Fortunately, there are plants which grew at high elevations not inhabited by large human populations. The rugged terrain and inhospitable environment for man enables certain plants to grow and survive in sites located at 17,000 ft elevation and above, it is these rare and isolated plant species that I propose for investigation thoroughly for their ethnobotanical and medicinal purposes. The Caryophyllaceae and Papaveraceae are two of the few plant families found at extremely high elevations in the Himalaya. There are references in literature of the area, yielding medicinal halo to some of these plants of the area.

It is but natural to expect a certain degree of disappointment while searching for truth and substance in this type of endeavour, especially the Himalaya where terrain imposes certain limitations and hardships. Coyness of the local inhabitants and the elite to part with their knowledge is obvious and the general habitat of the plants requires a unique blend of skill and proper background. It is a challenge wrought with great intellectual ramifications and rewards in the form of new drugs from these plants. I believe that there is a great need for a complete survey of the plants of the Himalayas to see if active principles of these plants are effective in the treatment of cancer or other dreaded diseases.

In addition, there seems to be a vital urgency to see if this vegetable world is safe from the onslaught of modern civilization and human encroachment. What, if anything, can be done to preserve this great gene pool of herbal wealth ! Based on the data collected in the field and the laboratory, it should be possible to suggest the medicinal derivatives of the plant species and ecological steps necessary for the safety of these plants for the present and future. This virgin area of scientific exploration should not be neglected in view of our constant search for medicinal plants for the treatment of dreaded diseases. Scientific literature is full of instances where neglect and indifference to folklore have caused human suffering and human life. *Rauvolffia* is a classic case in point : Mahatma Gandhi, like many millions before him in Asia, used to drink root-extract of *Rauvolffia* every night for a comfortable sleep. However, it was not until 1954 when modern science and pharmaceutical industry discovered the presence of reserpine in the plant for the treatment of high blood pressure. This is not to suggest that each and every plant with a folklore or a medicinal halo is going to fit into this classic example of *Rauvolffia or Vinca* or many others. However, it is equally important to recall that the history and record of the folklore for the plants of the Himalaya is quite impressive and unique in view of the cultural traditions of the area. We must begin to understand the enigma now !

The Himalaya have witnessed a turbulent time which is as frightening as their birth millions of years ago when the Indian peninsula hit the Eurasian mainland ! In the last few thousand years, the Moghuls, the Arabs, and the Europeans have followed the Aryans to this cradle of civilization and natural wealth and beauty and fought wars of religion, trade and politics. These human atrocities have destroyed some of the cultural and natural heritage of the area that we will never see again. Literary treatises and critiques of the natural wealth of the area have disappeared from the face of this earth and the loss is purely of the human race. We need to dig into the forgotten manuscripts—forgotten in this fast-moving world, and capitalize on the promise they seem to hold in the form of knowledge about the medicinal properties of the flora of the area.

The author wishes to thank the Rotary Foundation of Rotary International for the award of a University Teacher Grant. Acknowledgement is also extended to the University of Tennessee at Martin for financial assistance. Finally, I wish to express sincere appreciation to Dr. A. N. Purohit, Director of High Altitude Plant Physiology Research Centre at Garhwal University for his cooperation. ☐

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Letters to the editor

Lipolytic micro-organisms isolated from dry fruits

Different species of *Aspergillus* and *Penicillium* are known to be very active producer of lipase enzyme which bring about considerable hydrolysis of oils and fats. Usually, lipase occurred in cells of bacteria, fungi and actinomycetes and also found in media they grow[1].

Twelve micro-organisms frequently occurring in the kernels of Chironji (*Buchanania lanzan* Spreng.) and Walnut (*Juglans regia* Linn.) were isolated and identified[2,3]. Eleven of them were found to be capable of splitting fats by producing lipase and showed variable lipolytic activities (Table 1). The isolates were cultured and kept on slants of Czapek's-agar medium, the sub-culture being inoculated with spores from single conidial heads. Oils of healthy and deteriorated kernels of Chironji, Walnut and Olive oil (as control) were used as substrate (in media sucrose is replaced by experimental fat) in order to know the relative rate of lipase activity of fungi and bacteria. Czapek's doxagar and Rahn's medium using Nile-blue sulphate and Calcium chloride respectively, as indicator were selected for the experiment on the basis of their best and sensitive results. Intensities of colour changes, i.e. deep blue globules around the colony in Czapek's medium using Nile-blue sulphate and deposition of white salt around the colony in Rahn's medium using Calcium chloride, were taken as measure for lipase production and a positive test for hydrolysis. The medium was poured in sterilized petri-dishes and were inoculated with spore suspension (2-3 spores/drops) of test culture and incubated at 28±2°C for 15 days, five replicates were taken for each set[1].

Usually, all the species of fungi and bacteria, selected for the experiment exhibited the lipolytic activity, but the rate of activity was found to be different in all cases (Table 2). All the seven species of *Aspergillus* were found to be lipolytic (positive test). Out of them, *A. flavus* I could change the colour of the medium within three days, was categorized as strongly lipolytic. *A. niger* I was also strongly lipolytic over control, in oils of deteriorated Chironji containing Nile-blue sulphate and Calcium chloride, oils of healthy Chironji containing Calcium chloride, oils of healthy Walnut containing Nile-blue sulphate. *A. fumigatus* was strongly lipolytic (+test within 2-3 days) over control, while in oils of deteriorated Chironji and Walnut it was slow lipolytic (+test within 8-10 days) and in remaining cases only lipolytic (+test at the end of

TABLE 1 : **Isolation of fungi and bacteria from Chironji & Walnut kernels used for the Lipolytic activity on oils**

Isolate	Chironji	Walnut
Aspergillus flavus I	+	+
A. flavus II	+	+
A. fumigatus	+	+
A. niger I	+	+
A. nigar II	—	+
A candidus	+	—
A. ustus	+	—
Penicillium janthinellum	+	+
Rhizopus nigricans	+	+
Chaetomium globosum	+	—
Cocci	+	+
Bacilli	—	+

+ indicates 'Presence' ; — indicates 'Absence'.

TABLE 2 : Lipase activity of Fungi and bacteria on oils (Incubation Period—15 days ; Temperature 28±2°C)

Organism	Control		Chironji Oil				Walnut Oil			
	Olive Oil		HELE		DETER		HELE		DETER	
	NBS	$CaCl_2$	NBS	$CaCl_2$	NBS	$CaCl_2$	NBS	$CaCl_2$	NBS	$CaCl_2$
Aspergillus flavus I	+++	+++	++	++	+++	+++	++	++	+++	+++
A. flavus II	++	++	+	+	++	++	+	+	++	++
A. niger I	+++	+++	++	+++	+++	+++	+++	++	++	++
A. niger II	+	+	+	+	+	+	+	+	+	+
A. fumigatus	+++	+++	+	+	++	++	+	+	++	++
A. candidus	+	+	+	+	+	+	+	+	+	+
A. ustus	++	++	+	++	++	++	+	+	+	+
Penicillium janthinellum	++	++	+	++	++	++	++	+	++	++
Rhizopus nigricans	+	++	—	—	+	+	+	+	+	+
Chaetomium globosum	—	—	—	—	—	—	—	—	—	—
Cocci (Bacteria)	+	++	—	+	—	++	—	+	—	+
Bacilli	—	+	—	+	—	+	—	+	—	+

NBS = Nile-blue sulphate
$CaCl_2$ = Calcium chloride (Rahn's medium)
+++ = Strongly lipolytic (positive reaction within three days)
++ = Slow lipolytic (positive reaction within 8-10 days)
+ = Lipolytic (positive reaction at the end of incubation period, i.e. 15 days)
— = Non-lipolytic (negative reaction at the end of incubation period)
HELE = Healthy Oil (Oil from healthy kernels)
DETER = Deteriorated Oil (Oil from deteriorated kernels)

incubation period). *A. candidus* and *A. niger* II were found to be only lipolytic (+test within 15 days) in all cases. *Penicillium janthinellum* was found to be slow lipolytic, except in healthy oils of Chironji containing Nile-blue sulphate, healthy oil of Walnut containing Calcium chloride. *Rhizopus nigricans* showed absence of lipolytic activity (negative test) in oils of healthy Chironji containing Nile-blue sulphate and Calcium chloride, while in other cases it was only lipolytic except in control with Calcium chloride it was slow lipolytic. *Chaetomium globosum* the only one which was found to be non-lipolytic (negative test even after 15 days) in all cases. In case of bacteria, Cocci was found to be slow lipolytic in deteriorated oil of Chironji and in control containing Calcium chloride and non-lipolytic in healthy and deteriorated oils of Chironji and Walnut containing Nile-blue sulphate, while in remaining cases it was only lipolytic. Bacilli was non-lipolytic in oils of healthy and deteriorated Chironji and Walnut containing Nile-blue sulphate, and in remaining cases it was found to be only lipolytic.

The observations revealed that most of the isolated micro-organisms exhibited variable lipolytic activity but the rate of activity was found to be different. The reports also reveals that *Penicillium glaucum*[5,6], *A. niger* and in other strains of *Aspergilli*[7,8], as well as various strains of *Penicillium*[1,8] produced a very active soluble enzyme which hydrolysed the fat. The production of lipase enzyme and the rate of lipolytic activity were found to be different in oils of Coconut[9], stored corn[10], cotton[11], ground nut[12], sesame, cotton and Castor[1]. It has also been observed that fungi are capable of attacking oils and oilseeds very easily by means of lipase enzyme, resulting in splitting fats. The results indicated that organisms successfully utilized oils in stored oilseeds also[13].

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Received : 25 April, 1988.
Revised : 6 April, 1989.

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A new method for confirming the keratinolytic nature of fungi

Keratinophilic fungi are those micro-organisms which have affinity for keratin. They hydrolyse keratins which are in the form of eukeratins and pseudokeratins either partly or completely by the enzymes present within.

In the beginning, dermatophytes were the only fungi representing this group. With the discovery of other fungi having affinity for keratin, the group as a whole was renamed as *keratinofers*. English[1] suggested the usage of terms *keratinophilic* (fungi digesting the keratinaceous substrates completely or partly), *keratinolytic* (fungi hydrolysing keratinaceous substrates completely) and *dermatophytes* (species belonging to *Epidermophyton*, *Microsporum*, *Keratinomyces* and *Trichophyton*). Griffin[2,3] noted that a sterile hair, even though colonized by a succession of molds, often did not show keratinolytic properties. A method was described by Agrawal and Kushwaha[4] to determine the keratinolytic nature of a fungus. In this case, the fungi which is able to utilize the keratin of the hair as a sole source of nutrient or capable of attacking and digesting hair keratin was confirmed.

The present report offers a modified and simplified procedure for confirming the keratinolytic nature of fungi. Some of the fungi isolated from colonized hair, i.e. *Microsporum gypseum*, *Chrysosporium tropicum*, *C. indicum*, *Malbranchea* sp. and *Fusarium solani* were cultured on Sabouraud's Dextrose Agar in sterile petriplates. To confirm the keratinolytic nature, each individual fungus was inoculated in the middle of a sterile hair which is being tied at each end to a piece of glass rod and kept in a paired petriplate under aseptic conditions as shown in Fg. 1. A small amount of cotton dopped in distilled water was spread at the bottom of each glass rod to provide a humid atmosphere for the growing fungus. This cotton would also act as a cushion for the glass rods and keep them in position.

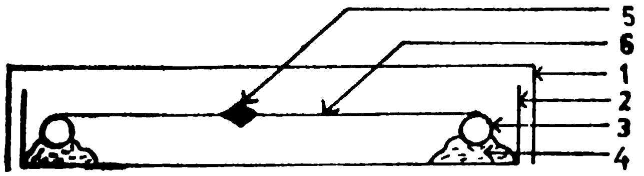

FIG.1.

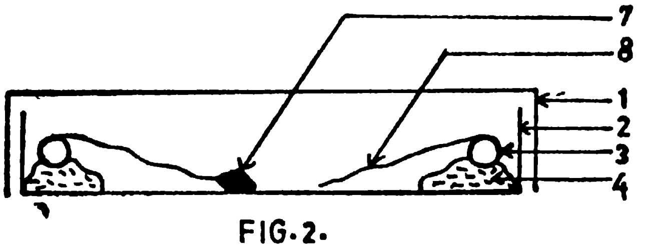

FIG.2.

1 = Upper Petriplate
2 = Lower Petriplate
3 = Glass rod
4 = Moist Cotton
5 = Inoculation of test fungus
6 = Human hair
7 = Colonization of test fungus
8 = Broken hair due to keratinolysis.

The whole assembly was kept in an incubator at 28 C for 20-50 days. The fungus developed a colony on the hair and its growth continued. After a few days, the hair was broken at the point of inoculation indicating the digestion of keratin of the hair and its disintigration by the test fungus (Fig. 2). The number of days taken by the fungi to digest the hair and to break it varied from species to species depending upon its keratinolytic nature (Table 1). This method was first employed by the authors during the course of isolation of soil inhabiting keratinophilic fungi and related dermatophytes for identifying and confirming the keratinolytic members of fungi.

TABLE 1 : Number of days taken by different fungi to digest the keratin hair

Name of species		No. of days taken to break the hair*
Microsporum gypseum	...	24
Chrysosporium tropicum	...	37
C. indicum	...	50
Malbranchea sp.	...	46
Fusarium solani	...	24

The authors thank Prof. G. M. Ram, Principal, St. John's College, Agra and Prof. S. S. Bhatnagar, Head of the Botany Department for facilities. Thanks are also due to Dr. Ipe M. Ipe of Zoology Department for inspiration and encouragement and the University Grants Commission, New Delhi for financial assistance.

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Evaluation of certain pre-emergence herbicides for their efficacy in weed control in upland rice

Weed problem in upland rice is very severe and yield losses upto 83% were reported[1 2]. The requirement of initial weed-free condition in this crop necessitates the use of pre-emergence herbicides. Hence, an evaluation of experimental herbicides developed from time to time to identify the promising ones becomes necessary. In a field experiment conducted during wet season of 1981 at Central Rice Research Institute, Cuttack, on a sandy loam soil of low fertility, six pre-emergence herbicides, viz. anilophos [S N (4-chloro-phenyl-)-N-isopropyl-carbamoyl-methl-)-O, O-dimethyl-dithiophosphate], pendimethalin [N-(1-ethyl propyl)-3, 4-dimethyl-2, 6-dinitrobenze-namine], oxadiazon [5-tert-butyl 3(2,4-dichloro-5-isopropoxy-phenyle-1, 3, 4-oxadiazol-2-one], piperophos (S-2-methyl-piperidinocarbonyl methyl OO-dipropyl phosphorodithioate), dichlormate (3,4-dichlorobenzyl methyl carbomate) and drepamon (S-benzyl N, N-di sec butyl thiolcarbamate) were compared with hand weeding (two times), weed-free (3 hand weedings) and unweeded checks. A short duration variety Annapurna was used in the studies. The crop was sown on 23 June with a spacing of 20 cm between the rows. A fertilizer level of 40 kg N, 20 kg each of P_2O_5 and K_2O per ha was adopted. All the herbicides were sprayed 2 days after sowing of the crop and using 500 litres of water per ha.

The results (Table 1) revealed that among the herbicides, oxadiazon at 0.75 kg a.i./ha and pendimethalin at 1.5 kg a.i./ha gave moderate weed control and next to hand-weeded treatments. The weed-control efficiencies of these herbicides were 72.7 and 63.4% respectively. In grain-yield performance, these two herbicides were similar to two rounds of hand weeding. Higher yield, in general, was associated with higher panicles and/or panicle

TABLE 1 : Effect of various pre-emergence herbicides on weed incidence, yield and yield components in upland rice, 1981 wet season

Treatment	Dry weight of weeds at harvest/ m² (gm)	Weed control efficiency (%)	Panicles/ m²	Panicle weight (gm)	Grain yield (kg/ha)	Herbicide efficiency index*(%)
Anilophos @ 1.5 kg a. i./ha	300.5	26.7	238	0.88	2579	0.32
Anilophos @ 2.0 kg a. i./ha	291.5	28.9	208	0.85	2654	0.38
Pendimethalin @ 1.5 kg a. i./ha	150 0	63.4	233	1.12	3065	1.10
Oxadiazon @ 0.75 kg a. i./ha	112.0	72.7	248	1.09	2935	1.47
Piperophos @ 2.0 kg a. i./ha	268.5	34.5	202	0.77	2850	0.55
Dichlormate @ 2.0 kg a. i./ha	331.0	19.3	175	0.56	2308	0.45
Drepamon @ 1.5 kg a. i./ha	402.5	1.9	194	0.73	2271	0.09
Hand-weeding twice	53.5	87.0	327	0.96	3804	—
Weed-free check (3 hand weedings)	44.0	89.3	308	0.93	4168	—
Unweeded check	410.0	—	151	0.68	2094	—
LSD (0.05)	116.0		80	0.26	906	

Herbicide efficiency index $= \frac{\text{Grain yield in herbicide treatment} - \text{Grain yield in unweeded check}}{\text{Grain yield in unweeded check}} \times 100$

$$\frac{\text{Dry weight of weeds in the herbicide treatment}}{\text{Dry weight of weeds in unweeded check}} \times 100$$

weight. The herbicide efficiency index, which takes into account both weed control efficiency and effects on crop growth[3] is higher (1.1 to 1.47) with these two herbicides (Table 1). The ideal performance of pendimethalin and oxadiazon for weed control in upland rice was earlier repoted by other workers[1,5].

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Melissopalynological study of the honey samples of Murshidabad district, West Bengal

Pollen analysis of the honey samples is known as melissopalynological[1]. Honey samples show differences in their microscopic content, particularly in the type of pollen-grains and their frequency[1]. Each sample has its own characteristic pollen spectrum and can be identified by their pollen-types, indicating their place of origin[1]. Pollen-types, originating from cultivated and also from wild varieties impart, a specific nutritive value to the honey as the pollen-grains collected are sources of vitamins, minerals and amino acids. In the present paper, the honey samples have been analysed in order to compare and correlate the pollen-spectra collected from the two different biozones of Murshidabad district, West Bengal. Characterization of the pollen-types and modes of pollination were also recorded. Morphology of the pollen-grains such as aperture, shape, size and ornamentations were also studied for proper identification.

Honey samples were collected in the months of August and September, 1987 from two different biozones of Murshidabad district, viz. Berhampore and Kandi and were palynologically analysed. Berhampore and Kandi, the two sub-divisions of the district Murshidabad, lies between 23°43′ and 24°52′ N latitude and 87°49′ and 88°44′ longitude and extends over an area of 5341 km^2 of which 5261 km^2 are rural and 80 km^2 are urban. These two biozones represent the urban (Berhampore) and rural (Kandi) areas. As the rural areas form the major part of the district, the biotic factors play very important role in moulding the vegetation and the emergence of natural flora is out of question in the thickly populated areas[2]. In general, the vegetation of the district falls under the tropical deciduous type with many members of the evergreens occurring here and there. The method for analysis of the pollen-types were followed according to Louveaux *et al*[3]. Two honey samples (about 20 ml) were diluted with distilled water, centrifuged and the water was decanted off. The pollen-samples were then prepared following the acetolysis method[4]. Two hundred pollen-grains were counted at random from each slide and the percentage of each type was worked out from their total count. The identification of the pollen-types was then done comparing the pollen-types of established identity collected from the same areas of the district.

In total, 19 pollen-types have been recorded from the honey samples of Murshidabad district (Table 1). Some of the pollen-types were common in between the samples, whereas other types were typical representatives of the adjoining flora. The honey samples contained pollen from the Brassicaceae, Bombacaceae, Meliaceae, Arecaceae, Rutaceae, Anacardiaceae, etc. The major pollen-types were ***Brassica integrifolia*, *Azadirachta indica*, *Bombax ceiba*, *Oryza sativa*, *Carica papaya*, *Cocos nucifera*, *Mangifera indica*** and ***Coriandrum*** sp. in various degrees of frequency of which the highest was ***Azadirachta indica*** for Berhampore and ***Brassica integrifolia*** for Kandi. The pollen morphotypes recovered from the honey samples were mostly entomophilous. A number of anemophilous pollen-grains are found in the honey samples like *Chenopodium album*, *Ipomoea* sp. and *Morus* sp.

TABLE 1 : Comparative pollen frequency of the honey samples of Murshidabad district West Bengal

Species	Family	Pollination mechanism	Pollen frequency	
			Berhempore	Kandi
Azadirachta indica A. Juss.	Meliaceae	E	33.5	10.2
Bombax ceiba L.	Bombacaceae	E	9.5	2.6
Borassus flabellifer L.	Arecaceae	E	3.0	1.8
Brassica integrifolia (West) Schultz.	Brassicaceae	E	1.2	40.8
Butea monosperma (Lam.) Taub.	Papilionaceae	E	2.5	—
Carica papaya L.	Caricaceae	A	6.5	2.8
Chenopodium album L.	Chenopodiaceae	A	2.8	1.6
Citrus sp.	Rutaceae	E	3.2	1.5
Cocos nucifera L.	Arecaceae	A	4.0	3.0
Coriandrum sp.	Apiaceae	E	—	4.0
Croton sp.	Euphorbiaceae	A	2.8	—
Ipomoea sp.	Convolvulaceae	A	2.3	2.6
Mangifera indica L.	Anacardiaceae	E	12.8	3.6
Morus sp.	Moraceae	A	4.8	—
Oryza sativa L.	Poaceae	A	7.5	10.2
Psidium guajava L.	Myrtaceae	E	—	4.5
Vernonia cinerea (L.) Less.	Asteraceae	E	—	1.5
Zea mays L.	Poaceae	A	3.6	2.5
Zizyphus mauritiana Lam.	Rhamnaceae	E	—	6.8

E=Entomophilous ; A=Anemophilous

The pollen analytical results distinctly reveal the heterogenous nature. Some pollen-types were found to be common in the two samples. The constitution of pollen assemblage was also found to be different, reflecting vegetational character of each individual biozone wherefrom the honey samples originated (Table 1). A pollen census of the collected honey samples shows the following types (primarily according to NPC classification): 1-porate, 1-sulcate, pantoporate, 3-porate, 3-colpate and 3-colporate with a number of varied exine patterns (Table 2). Some homogeneity in morphological characters of the grains like punctitegillate in *Azadirachta indica* and *Psidium guajava* and reticulate pattern in *Bombax ceiba*, *Brassica integrifolia*, *Citrus* sp., *Cocos nucifera* were represented by most of the pollen-types, suggesting the choice and preference of the bees to the individual pollen-types. The shape of the recorded pollen-types was variable, i.e. prolate, prolate-spheroidal, oblate-spheroidal and oblate, etc. There were few instances of pollen-types with echinate or psilate ornamentation (Table 2). Pollen-grains from anemophilous plants recorded a low frequency in the two samples. However, pollen-grains from the anemophilous plants may get mixed with the usual entomophilous type during collection by bees. However, the pollen frequency from anemophilous plants was much less than the entomophilous one which is in confirmity with the earlier work[5-8].

TABLE 2 : Pollen morphology of the identified taxa

Pollen-type	Habit	Pollen diagnosis			
		Aperture	Shape	Size (PA×ED)	Surface ornamentation
Azadirachta indica	Tree	4-colporate	Prolate-sph	40.0×38.0 μm	Punctitegillate
Bombax ceiba	Tree	3-colporate	Oblate	30.5×65.0 μm	Reticulate
Borassus flabellifer	Tree	1-sulcate	Oblate	40.0×70.0 μm	Verrucate
Brassica integrifolia	Herb	3-colpate	Prolate	36.0×28.0 μm	Reticulate
Butea monosperma	Tree	3-colporate	Oblate-sph	41.0×46.0 μm	Obscure
Carica papaya	Tree	3-colporate	Spheroidal	25.5 μm diam	Obscure
Chenopodium album	Herb	Pantoporate	Spheroidal	21.0 μm diam	Spinuliferous
Citrus sp.	Shrub	4-colporate	Spheroidal	32.0 μm diam	Reticulate
Cocos nucifera	Tree	1-sulcate	Oblate	39.0×63.5 μm	Reticulate
Coriandrum sp.	Herb	3-colporate	Prolate	40.5×18.0 μm	Reticulate
Croton sp.	Herb	Inaperturate	Spheroidal	36.0 μm diam	Crotonoid pattern
Ipomoea sp.	Herb	Pantoporate	Spheroidal	60.0 μm diam	Echinate
Mangifera indica	Tree	3-colporate	Prolate	34.5×27.5 μm	Fine processes
Morus sp.	Tree	3-porate	Spheroidal	36.5 μm diam	Scabrate
Oryza sativa	Herb	1-porate	Spheroidal	56.5 μm diam	Obscure
Psidium guajava	Tree	3-colporate	Oblate	18.0×27.5 μm	Punctitegillate
Vernonia cinerea	Herb	3 colporate	Prolate	36.0×30.0 μm	Echinate
Zea mays	Herb	1-porate	Spheroidal	90.0 μm diam	Scabrate processes
Zizyphus mauritiana	Tree	3-colporate	Sub-oblate	24.0×30.0 μm	Obscure

PA=Polar axis ; ED=Equatorial diameter ; Sph=Spheroidal

An analysis of the pollen content of the honey and also of the honey bee pollen-loads from bee baskets provide information on the honey plants. Thus, melissopalynological study provides useful information about the honey plants in the form of pollen index. This information about the pollen index in honey samples is important in laying a base for the organization of artificial apiary gardens throughout the country. On the basis of the frequency of pollen-types, the nomenclature of the honey can be made which also offer a method to check the adulteration of honey from various ecological and phytogeographical sites.

Sincere thanks are due to Prof. Sunirmal Chanda, Head, Division of Palynology & Environmental Biology, Bose Institute, Calcutta for the incentive given to the author for initiating this line of research. Thanks are also due to Prof. G. N. Bhattacharya, Head, Department of Botany, Visva-Bharati, Santiniketan, for his interest and encouragement in this study.

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Corynespora cassiicola (Berk. & Curt.) Wei, the incitant of a new fruit-rot disease of *Carica papaya* L. in Tamil Nadu

Papaya (*Curica papaya* L.), one of the most important fruit crops of India is grown extensively for its high nutritive value. During September-October 1987, the incidence of a new fruit-rot disease was noticed on papaya cv. Co-2 in the University Orchard, Coimbatore. The initial symptom of the disease was a chlorotic circular spot with a sunken centre on the surface of both young and matured fruits. The spot, later became olivaceous grey to black. Spores developed on the surface often in concentric rings. With the development of the disease, the spot covered the entire fruit surface and caused shrivelling. Similar description of the symptoms on papaya fruit due to *Corynespora cassiicola* has been reported by Quimio and Abilay[5] in Philippines.

The infected fruits collected were surface-sterilized by 0.1% mercuric chloride, placed in moist chamber and incubated at room temperature 28 ± 3°C. Within 12-24 hr, white mycelial growth became evident. Pure cultures were obtained by monospore technique. The fungus produced dark grey aerial mycelium on potato-dextrose agar. Sporulation was observed within 4-6 days of growth. Conidiophores were simple, straight or slightly flexuous, pale-brown, septate 52.0-145.5 μm to 4.0-7.58 μm. Conidia borne singly but often in chain at the apex, hyaline to light brown with 6-12 pseudoseptate and 65-78 μm × 12.0-18.5 μm. On the basis of cultural and morphological characters, the pathogen was identified as *Corynespora cassiicola* (Berk. & Curt.) Wei. and confirmed at Common Wealth Mycological Institute, UK (IMI No. 322856).

Pathogenicity of the fungus was tested on Co-2 papaya fruits. Young and matured fruits were surface-sterilized with 0.1% mercuric chloride and washed with sterile distilled water. The fruits were inoculated with a conidial suspension (10^5 conidia/ml) of the fungus grown on potato-dextrose agar. The inoculated fruits were incubated in humid chambers made of polythene bags for 48 hr. The controls were sprayed with sterile distilled water and incubated in the same manner.

The control fruits did not show any disease symptoms 5 days after inoculation. Characteristic fruit-rot symptoms appeared on 95% of the inoculated fruits as described for naturally infected fruits. Isolations from these lesions confirmed the presence of *Corynespora Cassiicola.* Though this pathogen has been reported on brinjal[1], tomato[3], pepper[1], castor[2], rubber[6] and tapioca[7] in India, its natural occurrence on papaya fruit has not been reported so far.

The authors are thankful to I. C. A. R., New Delhi for providing financial assistance and Dr. P. M. Kirk, Common Wealth Mycological Institute, for the identification of the fungus.

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Spot tests of organic compounds with reagents prepared with basic dyes

The use of dye-reagents prepared with toluidine-blue O, brilliant cresyl blue and Meldola's blue for chemical detection of different organic compounds has been reported by the present author[1]. All the three dye-reagents were used, after decolourising the dye solutions with N/H_2SO_4 and sodium sulphide ($Na_2S.2H_2O$) followed by filtration. By this procedure, colourless or pale straw-coloured reagents were obtained. In attempts to decolourise other basic dyes, the present author has found two dyes, both containing primary amino group in their molecules, which also can be reduced to a semi-colourless state with N/H_2SO_4 and sodium sulphide and can be used to detect various organic compounds including some of the steroid hormones through colour formation. With one of the dye-reagents, solid organic compounds can also be detected. Following is an account of the method of preparation of the dye-reagents and their use in the chemical detection of some organic compounds.

The dye-reagents using the two dyes, namely, thionine (Riedel, C. I. No. 52025), belonging to thiazine and cresyl fast violet (Fluka), belonging to oxazine group of dyes, were prepared as follows : 200 mg of each of the two dyes, were dissolved in two separate lots of 100 ml of warm distilled water. To each of these were added 5 ml of N/H_2SO_4 and 1.0 g of sodium sulphide. These were mixed thoroughly and filtered. The filtrates were of pale-straw colour that registered pH 10.0.

Since cresyl fast violet reagent reacted with chloroform, producing an upper straw layer and a lower golden yellow, no attempt was made to use this dye-reagent for the detection of solid organic compounds. Similarly, thionine dye-reagent reacted with chloroform, producing an upper straw and a lower red layer. There was, however, no reaction of this dye-reagent with solvent ether, except for a momentary violet colouration which disappeared on shaking. Under the circumstances, attempts were made to use this dye-reagent to detect solid organic compounds including some steroid hormones after dissolving these in solvent ether. The details of the colour reactions are presented in Table 1. It is apparent that thionine

TABLE 1 : Colour reactions of the different organic compounds with the two dye-reagents

Compounds	Thionine	Cresyl fast violet
I. Alcohols		
(a) Methanol	+ve (violet, colour disappears within secs.)	+ve (orange)
(b) Ethanol	+ve (magenta, a min later violet)	+ve (pale orange)
(c) n-propanol	+ve (deep violet within secs. deep yellow)	+ve (pale violet, within secs. pale yellow)
(d) n-butanol	+ve (violet, within secs. colourless)	+ve (upper pale orange ; lower colourless)
(e) iso-butanol	+ve (upper violet, lower colourless)	+ve (upper reddish-orange ; lower colourless)
(f) tert-Butanol	+ve (deep red)	+ve (reddish-orange)
(g) n-Pentanol	+ve (violet)	+ve (upper violet ; lower pale yellow)
II. Phenols		
(a) Resorcinol	+ve (upper deep violet ; lower pale yellow)	Not possible
(b) Quinol	+ve (upper deep violet ; lower pale yellow)	Not possible
III. Aldehydes		
(a) Formaldehyde	+ve (pale violet, within secs. colourless)	+ve (pink on shaking, then colourless)
(b) Acetaldehyde	+ve (sky-blue, cloudy)	+ve (blue)
(c) Glutaraldehyde	+ve („)	+ve (pale green)
(d) Paraldehyde	+ve (blue)	+ve (upper violet ; lower blue)
(e) Benzaldehyde	+ve (golden yellow, cloudy, with violet ppt.)	+ve (upper pale blue ; lower violet)
(f) Salicylaldehyde	+ve (yellow-green with violet ppt.)	+ve (upper pale yellow ; blue-violet ppt)
(g) p-hydroxy benzaldehyde	+ve (deep red)	Not possible
(h) Vanilin	+ve (upper yellow ; lower pale yellow)	Not possible
(i) Veratraldehyde	+ve (upper deep violet ; lower pale yellow)	Not possible
IV. Ketones		
(a) Acetone	+ve (magenta)	+ve (reddish-orange)
(b) Methyl ethyl ketone	+ve (pale brown ; 5 min later colourless)	+ve („)
(c) Benzophenone	+ve (upper deep violet ; lower colourless)	Not possible

TABLE 1 *(Contd.)*

Compounds	Thionine	Cresyl fast violet
V. Carboxylic acids		
(a) Linoleic acid	+ve (upper navy blue ; lower colourless)	+ve (upper violet ; lower colourless)
(b) Oleic acid	+ve (upper blue ; lower colourless)	+ve (upper violet ; lower colourless)
(c) Phenylacetic acid	+ve (upper colourless ; lower golden yellow)	Not possible
(d) Phthalic acid	+ve (upper colourless ; lower milky)	Not possible
VI. Amines		
(a) Tributylamine	+ve (upper violet ; lower colourless on standing)	+ve (upper golden-yellow ; lower colourless)
(b) Dimethylaniline	+ve (upper red , lower colourless)	+ve („)
(c) Pyridine	+ve (pale brown, within secs. pale yellow)	+ve (red)
VII. Steroid hormones		
(a) Testosterone propionate	+ve (upper violet ; lower colourless)	Not possible
(b) Progesterone	+ve („)	Not possible
(c) Hydrocortisone	+ve („)	Not possible
(d) Deoxycorticosterone	+ve („)	Not possible

dye-reagent is most suitable for chemical detection of all the organic compounds, both solid as well as liquid ones. The steroid hormones, however, can be detected only on standing. Cresyl fast violet dye-reagent is only suitable for liquid ones.

None of the dye-reagents reacted under shortwave UV rays nor could these be used to detect DNA-aldehyde molecules of acid hydrolysed tissue sections, although liquid aldehydes could be detected with these reagents. Furthermore, there was no change of colouration in any of the dye-reagents even when these were left under the usual laboratory conditions for 24 hrs.

It is pertinent to mention here that cresyl fast violet dye-reagent, prepared with perchloric acid[2] gave rise to a pale yellow-coloured liquid which when mixed with the different organic compounds revealed colouration which are very different from those obtained with the present reagent. The thionine dye-reagent, prepared with perchloric acid plus conc. sulphuric acid[3] produced a pale-green reagent that reacted with the different solid as well as liquid organic compounds revealing colouration which are also very different from those obtained with the present reagent employing this dye. Under the circumstances, it is possible to conclude that the molecules of these dyes are differently altered when prepared as reagents differently and that these dye-reagents (molecules) react with the organic compounds producing different colours depending upon the methods of preparation of the reagents.

M. K. DUTT

Department of Zoology,
University of Delhi,
Delhi 110007.

Received : 30 August, 1988.

[1] M. K. Dutt, *Sci. & Cult.*, **49**, 247, 1983
[2] M. K. Dutt, *Sci. & Cult*, **50**, 123, 1984 **a**.
[3] M. K. Dutt, *Sci. & Cult.*, **50**, 158, 1984 **b**.

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Jawaharlal Nehru Awards for Outstanding Post-Graduate Research in Agriculture 1989

The Indian Council of Agricultural Research invites applications from post-graduate students who have obtained their Ph.D. degrees during the year 1988 in the fields of agriculture/animal sciences (including fisheries) and home science for "Jawaharlal Nehru Award for Outstanding Post-graduate Research in Agriculture—1989". There will be ten prizes of Rs. 5,000/- each for outstanding research work of the following nature :

(i) which may have bearing on finding a solution to any important national problem in the field of agriculture/animal sciences, and/or

(ii) which is likely to have an impact on increasing the production or improving the quality of any important crop for human nutrition or animal productivity or increasing the technological efficiency of any process of economic importance connected with agriculture.

Candidates shall be required to submit the following documents through the Head of the Institute from where the thesis has been obtained :

(1) A copy of the thesis submitted by them for the award of the doctoral degree.

(2) A certificate from the guide of the candidate for Ph.D. degree stating the extent to which the work is the candidate's own contribution.

(3) 6 copies of the synopsis indicating precisely and in concise terms the work done by the candidate.

(4) 6 copies of the bio-data with complete address for correspondence with telegraphic address if possible.

The certificate awarded to the candidate for Ph.D. degree may also be sent. There is no prescribed proforma for applying for this award. Each candidate will be judged on the basis of the originality and the applied value of the investigations as revealed in the thesis submitted by him. In all matters relating to the award the decision of the Council shall be final and no correspondence on this account will be entertained.

Applications, with complete documents as mentioned above, addressed to Shri C. R. Mohapatra, Director (D), Department of Agricultural Research & Education, Krishi Bhawan, New Delhi-110 001, should be sent so as to reach on or before 31st August, 1989. The last date for candidates in the Andaman and Nicobar Islands, Lakshadweep, States/Union Territory in the North Eastern Region, Ladakh Division of J & K State and Sikkim is 15th September, 1989. The award winning thesis will be retained by the Council for record. In case the application is not accompanied by a copy of thesis and the required number of synopsis and bio-data, the application is liable to be rejected at the screoning stage.

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Hari Om Ashram Trust Awards for the Year 1989

Nominations are invited for the Hari Om Ashram Trust Awards for the year 1989. Three awards of the value of Rs. 10,000/- each in cash or kind or both are given every year for outstanding original research fundamental or applied work done in India, including inventions, discoveries etc. leading to results of practical value in any field or subject within the purview of research in agricultural sciences, forest farming and social forestry and animal sciences (including fisheries).

All scientists engaged in research in the fields of agriculture, forest farming and social forestry, animal husbandry and allied sciences in India shall be eligible for the awards. The results of research achieved/contributions made during the five years preceding the year of the award shall only be considered for the awards. In the case of claims based on evolution of new varieties/strains, the final trials should have been completed within five years preceding the year of award.

Nominations can be made amongst others by Vice-Chancellors of agricultural universities or other universities having faculty of agricultural or biological sciences, Directors of Research Institutes, including Principals of agricultural and veterinary colleges, Presidents of Scientific Societies, Academies and heads of the Principal Scientific establishments in the country.

Nominations for the awards should be supported by a statement of work, achievement accomplished or performed by the candidate who is being nominated and a reasoned justifications or other supporting data.

The last date for receiving nominations for the awards is 31st August, 1989. The last date for candidates in the Andaman and Nicobar Islands, Lakshadweep, States/Union Territory in the North Eastern Region, Ladakh Division of J & K States and Sikkim is 15th September, 1989. Five copies of the nominations on the prescribed proformae for the award should be sent in a sealed cover marked "Confidential" to Shri C. R. Mohapatra, Director (D), Department of Agricultural Research & Education, Krishi Bhawan, New Delhi-110 001. The copy of the proforma can be obtained from him by sending a self addressed envelope of the size of 27 cm x 12 cm. Applications/nominations received without five sets of reprints of publications are liable to be rejected at the scrutiny stage.

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Rafi Ahmed Kidwai Memorial Prizes for Agricultural Research for the Biennium 1988-89

Nominations are invited for the Rafi Ahmed Kidwai Memorial Prizes for Agricultural Research for the biennium 1988-89, carrying an amount of Rs. 10,000/- (Rupees ten thousand only) in cash or kind or both, a citation and a certificate.

The award is given once in two years to Indian scientists for outstanding research, fundamental or applied, including inventions, discoveries, etc. leading to results of practical value in any field or subject within the purview of research in agriculture, animal husbandry and fisheries, including agricultural economics, agricultural statistics and nutrition. Only results of researches/contributions made during the five years preceding the year of award shall be considered for the award. In the case of claims based on evolution of new varieties/strains, the final trials should have been completed within five years preceding the year of award.

Nominations can be made amongst others by Vice-Chancellors of agricultural universities/general universities with faculties of agriculture or biological sciences, Directors of research institutes, including Principals of agricultural and veterinary colleges, Presidents of Scientific Societies and academies and heads of the Principal scientific establishments in the country such as CSIR, BARC etc.

Nominations for the award should be supported by a statement of work, achievement accomplished or performed by the candidate who is being nominated and a reasoned justification for the nomination together with reprints of publications or other supporting data. In all matters, decision of the Council shall be final and no correspondence on this account will be entertained.

The last date for receiving the nominations for the award is 31st, August, 1989. The last date for candidates in the Andaman and Nicobar Islands, Lakshadweep. States/Union Territory in the North Eastern Region, Ladakh Division of J & K State and Sikkim is 15th September, 1989. Proposals in quadruplicate) on the prescribed proforma for the award should be sent in a sealed cover marked 'Confidential' to Shri C. R. Mohapatra, Director (D), Department of Agricultural Research & Education, Krishi Bhawan, New Delhi-110 001. The copy of the proforma can be obtained from him by sending a self addressed envelope of the size of 27 cm x 12 cm. Applications/nominations received without four sets of reprints of publications are liable to be rejected at the scrutiny stage.

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Dr. Rajendra Prasad Award for the Best Original Standard Works in Hindi on Agriculture Including Animal Sciences and Fisheries—1989

Applications are invited for Dr. Rajendra Prasad Award for the year 1989 for standard original books/manuscripts in Hindi on agriculture, including animal sciences and fisheries published/written between April 1988 to March 1989. Books written by more than one author can also be considered. Five copies of the books/manuscripts for the award may be sent in a sealed cover marked 'Confidential' to Shri C. R. Mohapatra, Director (D), Department of Agricultural Research & Education, Krishi Bhawan, New Delhi-110 001, latest by 31st August, 1989 in a prescribed form obtainable from him. The last date for candidates in the Andaman and Nicobar Islands, Lakshadweep, States/Union Territory in the North Eastern Region, Ladakh Division of J & K State and Sikkim is 15th September, 1989.

In all matters relating to the award the decision of the Council shall be final and no correspondence on this account will be entertained.

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Fakhruddin Ali Ahmed Award for Agricultural Research in Tribal Areas for the Biennium 1988-89

Nominations are invited for the Fakhruddin Ali Ahmed Award for agricultural research in tribal areas for the biennium 1988-89. Two prizes of the value of Rs. 10,000/- (Rupees ten thousand only) each in cash or kind or both will be awarded for outstanding original research carried out in the tribal areas in the field of agricultural sciences and animal sciences including fisheries.

All research workers engaged in research in agriculture, animal husbandry, fisheries and allied sciences in tribal areas (Tribal areas for this purpose are those notified by the Ministry of Home Affairs, Govt. of India) shall be eligible for the award. The results of research achieved/contributions made during the five years preceding the year of the award shall only be considered for the award. In the case of claim based on evolution of new varieties/strains the final trials should have been completed within five years preceding the year of the award.

Nominations can be made amongst others, by the Vice-Chancellors of the agricultural universities or other universities which have a faculty of agricultural or biological sciences, Directors of research institutes including Principals of agricultural and veterinary colleges, Presidents of scientific societies, academies and heads of Principal scientific establishments in the country such as Council of Scientific and Industrial Research, Bhaba Atomic Research Centre, etc. Each nomination for this award should be accompanied by a detailed statement of work and attainments of the nominee and a reasoned justification for the nominations together with the reprints of publications or other supporting data. Also, a certificate of residence in the tribal area where the work has been done, obtainable from Head of the Institutes, should be appended. It is emphasised that the award is intended for recognising outstanding research carried out in tribal areas and hence the scientist(s) concerned should have lived and carried out the research in any of the tribal areas notified by the Ministry of Home Affairs.

The last date for receiving nominations/applications is 31st August, 1989. The last date for candidates in the Andaman and Nicobar Islands, Lakshadweep, States/Union Territory in the North Eastern Region, Ladakh Division of J & K State and Sikkim is 15th September, 1989. Four copies of the nominations on the prescribed proforma for the award should be sent in a sealed cover marked 'Confidential' to Shri C. R. Mohapatra, Director (D), Department of Agricultural Research & Education, Krishi Bhawan, New Delhi-110 001. The copy of the proforma can be obtained from him by sending a self addressed envelope of the size of 27 cm × 12 cm. Nomi-ations received without four sets of reprints of publications are liable to be ected at the scrutiny stage.

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

ICAR Awards for Team Research for the Biennium 1989-90

Nominations are invited for ICAR Award for Team Research for the biennium 1989-90, The award is given once in two years to inter-disciplinary teams of research workers for outstanding research work in the field of agriculture including agricultural economics and statistics, animal husbandry and fisheries in the form of a scroll of honour and a medal to each member of the award winning team.

All scientists engaged in research in the field of agriculture, animal husbandry and fisheries sciences in India shall be eligible for the award. The award of each prize shall be made for notable and original inter-disciplinary research both furndamental and applied as reflected in books, monographs, papers or other forms of published account of outstanding research work, inventions or discoveries. In the case of contributions like new crop varieties or new breeds of animal at least 3 years' data on the performance of the strains will have to be provided. The results of research achieved/contributions made by the team should be during the five years preceding the year of award.

Nominations can be made amongst others by Vice-Chancellors of agricultural universities or other universities having faculty of agricultural or biological sciences, Directors of research institutes including principals of agricultural and veterinary colleges, presidents of scientific establishments in the country such as CSIR, BARC etc.

Nominations for the award should be supported by a statement of the inter-disciplinary team work, achieved accomplished or performed by the team which is being nominated and a reasoned justification for the nomination together with the reprints of publications or other supporting data. In all matters relating to the award the decision of the Council shall be final and no correspondence on this account will be entertained.

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The following examples may be referred :

(i) R. B Walton and H. B. Woodruff, *F. Clin. Inst.*, **82**, 924, 1949.

(ii) W. C. Boyd, Fundamentals of Immunology, 1947, p. 123. (Interscience Publishers Inc., New York).

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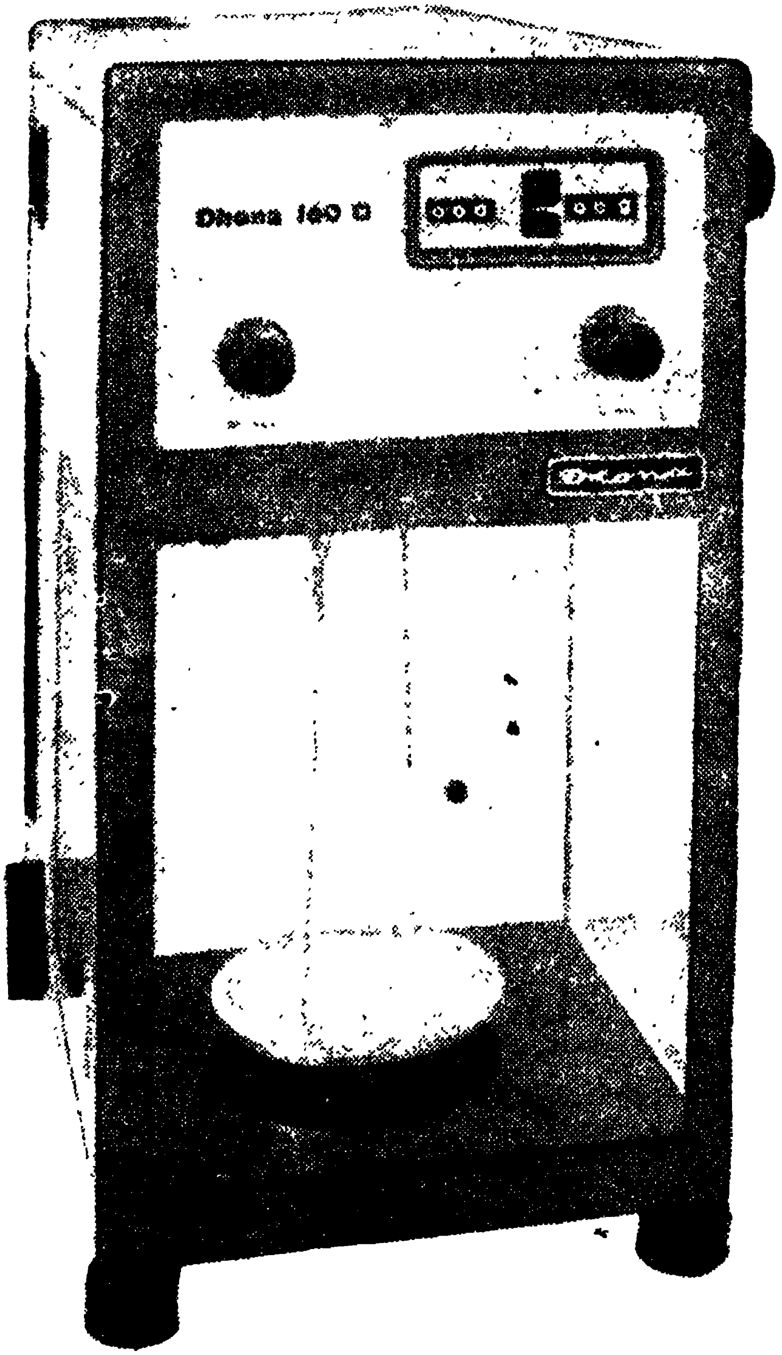

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Published and Printed by Santimay Chatterjee, on behalf of the Indian Science News Association,
92, Acharya P. C. Road, Calcutta-700 009 at B. G. ART PRINTERS ★ CALCUTTA-700 054.

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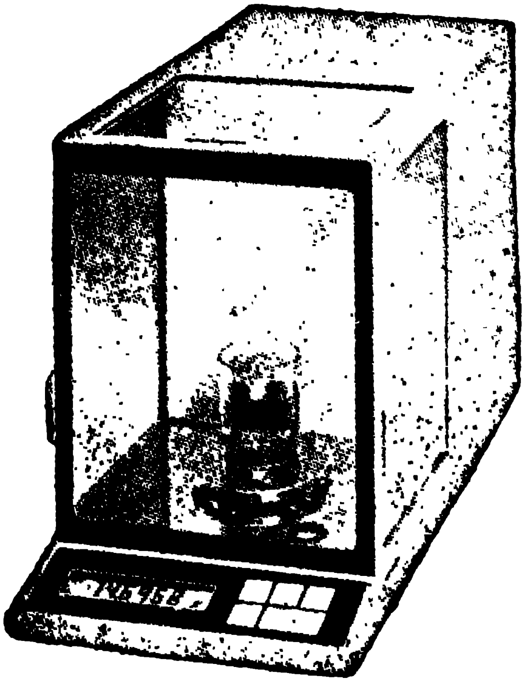

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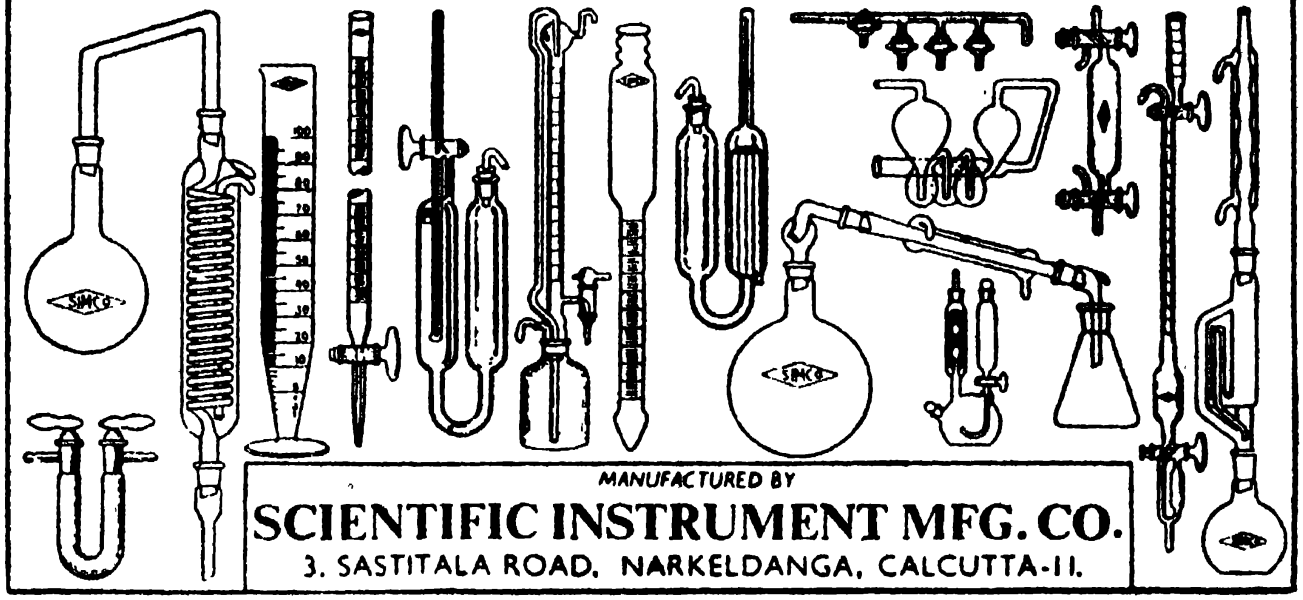

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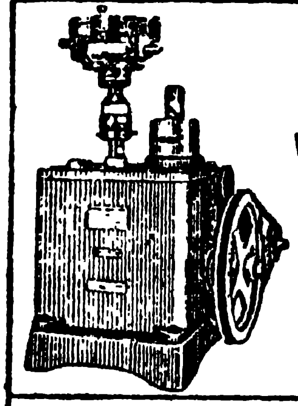

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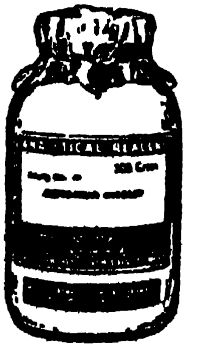

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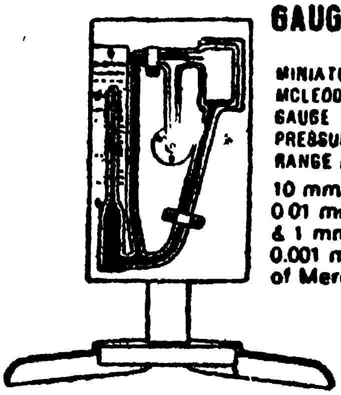

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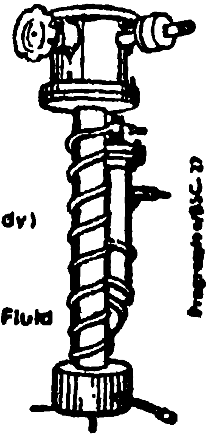

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A MONTHLY JOURNAL OF NATURAL & CULTURAL SCIENCES

June 1989 / Volume 55 / Number 6

PUBLISHED BY THE

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SCIENCE & CULTURE

VOLUME 55 ☐ JUNE 1989 ☐ NO. 6

THE PLEA FOR A NATIONAL FLORA

TWO dates are still vivid in my memory: May 8, 1969 and May 7, 1986. On the first occasion, I happened to be presented with a copy of the first volume of *Flora Palaestina* by Michael Zohary on the eve of my departure from Israel after a fruitful stay at the Hebrew University of Jerusalem. The second occasion was a courtesy call on 84-year-old Naomi Feinbrun of the same University (in course of my second visit to the Holy Land) when the press copy of the fourth and final volume of the same flora was brought to her for perusal.

On each date, I was confronted with two usual questions: "What are you doing about the *Flora of Free India*? Are you still using the *Flora of British India*?" I had no ready-made answers at that time neither do I have even one now when I go abroad on scientific pursuits.

For a country so tiny (excluding the occupied territories, twice the size of Tripura), the project of an Israeli national flora was piloted by a two-member team—Zohary and Feinbrun—after their retirement from active service of the University. After Zohary breathed his last in 1975, Feinbrun carried on the assignment single-handedly till the target was achieved. Our two neighbours—Pakistan and Sri Lanka—made enormous strides in preparing their flora and that with foreign aid. We in India are miserably and sadly lagging behind 42 years after independence, while Europe (minus USSR the size of India) took 25 years to complete the job.

Realising the great dependence of many fields of science on raw material derived from the Plant Kingdom, in 1952, the Government of India decided to revive the Botanical Survey of India which was established by George King in 1890 and became defunct after the retirement of C. C. Calder in 1939 from the Royal Botanic Garden (at present, Indian Botanic Garden), Howrah. The main objectives of the revived and re-organised Botanical Survey include (a) exploration of unexplored and underexplored regions for new plant resources; (b) preparation of floras at the local, district, regional and national levels; (c) floristic and taxonomic researches; (d) preservation of types and other authentic specimens by establishing herbaria and musea and exchange of plant specimens in India and overseas; (e) maintaining germplasm of economic, rare and interesting plants for conservation and education ; (f) study of phytogeography and ecological changes in flora and vegetation ; (g) investigation of threats to floras and habitats and conservation of ecosystems and (h) advising the Government on all matter relating to the utility and conservation of natural plant resources of the country.

Besides over 2,500 research papers published by scientists of the Botanical Survey during the last 37 years of its re-organisation, major activities in publication embrace reprinting of the regional floras of Bombay (T. Cooke), Madras (J. S. Gamble), Bihar and Orissa (H. H. Haines), Bengal (D. Prain) as well as publishing a Check List of Indian Plants ; a dozen fasicles of the Flora of India ; Roxburgh's Icones ; Aquatic Angiosperms (Subramanyam, 1962) ; Illustrations of West Himalayan Flowering Plants (Rau, 1963) ; Flora of Rajasthan (Puri *et al.*, 1964) ; Phycologia Indica (Srinivasan, 1969) ; Dictionary of Flowering Plants in India (Santapau and Henry, 1973) ; High Altitude Flowering Plants Rau, 1975) ; Flora of Bashahar Himalayas (Nair, 1977) ; Flora of Punjab Plains (Nair, 1978) ; Orchids of India (Rao, 1979) ; Flora of Jowai (Balakrishnan, 1981) ; Medicinal Plants (Jain, 1981) ; Beautiful Trees and Shrubs of Calcutta (Chakraverty and Jain, 1984), etc. More than 150 new taxa has been described and interesting genera such as *Eskemukherjea*, *Parakaemferia*, *Pauella*, *Pavia* and *Seshagiria* are new to science. During the last four decades, the Survey has organised the collection of more than 300,000 field numbers and the herbaria of the Survey is the treasure-trove of over 2 million plant specimens. These contributions have created a great deal of enthusiasm among Indian botanists to revise the State floras where they exist and to prepare new ones where they are lacking.

Currently, the Botanical Survey is ready to implement projects for the revision of families for the proposed flora of India. The spade work for the flora project was laid more than a decade ago and during the regime of Sunil K. Mukherjee who served as the then Director. Even then, the flora project was not accorded a top priority until recently. High hopes were raised when T. N. Khoshoo was appointed as the Secretary, Department of Environment (which has become more diffuse by including Forests and Wildlife), Govt. of India, and the Botanical Survey and Zoological Survey brought under the common umbrella. In order to streamline the activities of both Surveys, Khoshoo deserve all kudos for appointing a Review Committee which toured different sectors of the country and submitted an elaborate report (with special emphasis on the publication of flora and fauna) in August, 1985. That report still remains in cold storage, since there was a rapid change of three Secretaries in the Department of Environment in course of the next six months. Whereas the Zoological Survey under the stewardship of the last Director made considerable progress towards the country's fauna, the Botanical Survey merely contented itself by publishing a few fasicles which were not well-knit and coherent account of taxa from the major groups of flowering plants. The latter development led one wag to comment that the Botanical Survey would take 25 years to complete the national flora if it continued merrily with the required quota of fasicles !

As every dark cloud has a silver lining, all is not lost. Of late, the present Director of Botanical Survey, has been up and doing. The

Survey envisages the publication of a 16-volume series to cover the plant wealth of the country, each volume containing approximately 500 pages. There is also tremendous pressure from the Centre now to expedite the work on the national flora.

There is a feeling in the minds of many a botanist that the present Director may see through the printing of at least three or four volumes of the proposed flora during the period of his active service. What would happen to the Botanical Survey when he retires in 1990 and 49 top-ranking officers of the Survey follow him within the next five or six years ? Will the Survey carry on the job undaunted and sustain the progress made by him ? It is high time that the authorities concerned ponder over generating a task-force to oversee the publication of the flora of free India so that the goal is reached before we move to the 21st century. This can be attained by retaining the services of those impending retirees presently involved in the preparation of the flora and grooming up worthy successors from the grass-roots level. Also, the challenge should not be faced by the Survey alone and people from the Colleges and Universities should come forward to render assistance to the Survey (apart from their participation in the work of district, state or regional floras).

The national flora is not the sole responsibility of the Botanical Survey but of the entire country which is endowed with a huge man-power. The task is undoubtedly stupendous, but the spirit of dedication and determination would see us through. The sooner the task is accomplished the better for Indian botany. Otherwise, we would be stuck with the ***Flora of British India*** (which was first published in 1875) and we would then become the butt of international ridicule from small and under-developed countries. Will the Botanical Survey deliver us the goods before we plunge headlong into the next century ? Will the national flora remain a pipe dream ? Will it be converted into a stern reality ? ☐

S. C. Datta

PLATINUM JUBILEE CELEBRATIONS OF CALCUTTA UNIVERSITY COLLEGE OF SCIENCE, TECHNOLOGY & AGRICULTURE

On 27th March 1914 Sir Asutosh Mookerjee laid the foundation of the University College of Science which over the years has flowered into University College of Science, Technology and Agriculture. 75 years is a long time in the life of any Institution and at times it rose to such exalted position that very few institutions in India could claim to have such an experience. This is the only University in India which could claim a Nobel Laureate on its faculty of science. It set a trend for university laboratories for research. Thus the celebration of platinum jubilee was an important occasion and was done befittingly The first part gives an introduction by Prof. R. K. Poddar, Ex-Vice-Chancellor of Calcutta University, which traces the history of college and the second part is a report of the whole week of celebrations (starting from March 27, 1989) by Prof. S. P Mukherjee. A number of interesting seminars and lectures took place during this period *Science & Culture* whose office is in this college campus, will try to procure as many lectures as possible and present them in future issues.—*Ed.*

Introductory Remarks

—*R. K. Poddar*

We are today celebrating a momentous event in the history of our 132-year old *Alma mater*. 75 years ago, on this auspicious day i.e. on 27th March, 1914, Sir Asutosh Mookerjee laid the foundation stone of the University College of Science and Technology at this campus, just 4 days before his retirement from his 8-year long tenure as Vice-Chancellor. Later on, another campus of this University College was built up at Ballygunge and a separate Faculty of Agriculture was included.

If we look back—and this is a fit occasion for looking back, we would see that the launching of the University College of Science & Technology was far from a smooth affair ; on the contrary, it was preceeded by decades-long protracted struggle by our patriotic educationists to pursuade the then alien and unfriendly Government to agree to convert our University from a mere examining body to a true national centre of postgraduate study and research. The setting up of the University College of Science and Technology was the most important component of this struggle. For more than half a century since its inception in 1857, our University's sole academic activity consisted in conducting examinations—(Matriculation upwards) –of students from affiliated schools and colleges of the subcontinent ranging from Afganisthan to Burma which was under the then British Empire.

Contact with European Enlightenment during the 19th century convinced our national leaders like Raja Ram Mohon and Iswar Chandra Vidyasagar that we could also remove our backwardness and take our proper place among the nations of the world, if we had our own centres of modern education for our citizens. Events following the ill-fated partition of Bengal in 1906 clearly indicated that the self-reliant socio-economic development of our country through absorption of science and technology was perhaps the last thing the Imperialist Government desired.

Patriots of Bengal did not, of course, passively accept this gloomy situation. Towards the end of 1912 a most notable thing happened. Sir Taraknath Palit, an eminent lawyer, donated to the University land and money worth a sum of Rs. 13 lakhs towards the foundation of the University College of Science & Technology so that 2 Professorships, one each in Physics and Chemistry, could be maintained out of the income of the endowment. In 1915, another distinguished lawyer, Sir Rashbehary Ghose came forward with an offer of Rs. 10 lakhs so that 4 more Professorships could be created, one each for Applied Mathematics, Physics, Chemistry and Botany with special reference to agriculture. Armed with these munificent gifts, Sir Asutosh could ultimately overcome the Government apathy and realise life-long dream of establishment of a "Teaching University of Calcutta".

The first incumbents were Chandrasekhar Venkata Raman for Physics and Prafulla Chandra Ray for Chemistry as Palit Professors. Ganesh Prasad, Shankar Purosattam Agharkar, Debendra Mohan Bose and Prafulla Chandra Mitter occupied the first Ghosh Professorships in Applied Mathematics, Botany, Physics and Chemistry, respectively. Thanks to his pursuasive skill and magnetic personality, Sir Asutosh could attract such distinguished scientists who would have added lustre to the roll of honour of the any University of the world.

The twenties, the thirties and the forties were the period of reform, reorganisation and full-flowering of our University College. In fact, this period may be called our Golden Age ; C. V. Raman received the Nobel Prize, Satyendranath Bose discovered Bose-Einstein Statistics, Meghnad Saha formulated the famous Thermal Ionisation Theory and Sisir Kumar Mitra made his pioneering contributions in Ionospheric research. Other distinguished scientists who adorned our Professorships during this period include Jnandranath Mukherjee, Priyadaranjan Ray, Pulinbehary Sarkar, Bires Chandra Guha and Jogendra Chandra Bardhan in various branches of Chemistry, Nikhil Ranjan Sen and Friedrich Levi in Applied and Pure Mathematics, Paul Brühl and Prabhatchandra Sarvadhikari in Botany, Nagendranath Ganguli and Pabitra Kumar Sen in Agriculture and Himadri Kumar Mukherjee in Zoology.

We most gratefully remember these great teachers today because it was their devotion and persistent struggle for excellence that did raise the standards of study and research here to an international level—and that also inspite of partly salaries and uncertain tenures of those days. We remember them because they were also the pioneers—especially Prafulla Chandra Ray, Meghnad Saha, Bires Chandra Guha and Upendranath Brahmachari amongst them—who brought academic science and technology to the service of economic development in the fields of industry, agriculture and medicine and thus initiated the culture of self-reliance for the whole nation to emulate.

Since 1960's our University College has been able to keep pace with modern developments by introducing new avenues of study and research, especially in interdisciplinary areas. Quality of our training, I am proud to say, is appreciated not only in India but also abroad. Quite a few of our alumni hold top positions in Europe and America. I have recently gathered that our students usually win 30-40% of openings for Research Fellowships at the Tata Institute of Fundamental Research, Bombay, and Indian Institute of Science, Bangalore, through admission tests conducted on All India basis. Performance of our students is also very commendable at the National Educational Tests for Research Fellowships of the UGC and the CSIR.

Our University College also nursed several research institutes. Saha Institute of Nuclear Physics which grew out of our Palit Laboratory of Physics, has earned both national and international recognition on its own. Institute of Jute Technology was set up in collaboration with Indian Jute Mills Association. We are very glad that in this Platinum Jubilee year our University is actively considering the setting up of an Institute for Atmospheric Research and an Institute of Genetic Engineering & Biotechnology. Several University departments and sections now enjoy the status of the UGC's Centre of Advanced Studies. These include the Institute of Radiophysics & Electronics, Centre for Study of Natural Products, Centre for Chromosome Research, etc. New departments and study programmes like Computer Science, Marine Science, Electronic Science, Opto-Electronics, Environmental Science and Biophysics & Molecular Biology have been started in recent years.

During the post-independence years, the number of Universities in India increased from about 15 to 115, and that of Research Institutes from a handful to at about 350. Financial worries of Sir Asutosh's days are now past memories. Universities now handle crores, instead of lakhs or thousands of rupees. We must, however, admit that we are finding it difficult to maintain the standards of excellence set up by our predecessors with so little facilities. I do not want to dilate on the many subjective and objective factors engendering this sorry state of affairs. Such issues will be discussed threadbare in our afternoon seminar. Here I would only emphasize that, after every thing is said and done on this auspicious occasion, the quality of the University will, in the ultimate analysis, depend on the quality of its teachers. Only good teachers can develop talents and inspire students to take up of challenges of the expending frontiers of Science & Technology. Let me conclude by quoting from the Gift deeds of our original Donors that the distinctive duties of a University Professor should be :

(a) "*To carry on original research in his special subject with a view to extend the bounds of knowledge and to improve by application of his researches the arts, industries, manufactures and agriculture of this country.*"

(b) "*To stimulate and guide research by advanced students and generally to assist them in post-graduate work so as to foster real learning amongst our own men*".

Although enunciated more than 75 years ago, these noble principles are equally valid today. In fact, they would still be valid 75 years later. If we succeed in upholding them, we will continue to be a premier Centre for advancement of scientific and technological learning in the service of our country. □

Report

-*S. P. Mukherjee*

Remembering that the foundation-stone of the Science College building on 92, A. P. C. Road was laid on March 27, 1914 by Sir Asutosh Mookerjee (the then Vice-Chancellor), the University decided to observe the Platinum Jubilee year of the University College of Science, Technology and Agriculture in a befitting manner. The first phase of the jubilee celebrations held during March 27-31, 1988 was one of the most impressive and memorable occasions in the recent history of the University. The celebrations will continue till March 26, 1990 and steps to introduce some endowment lectures, to establish a few inter-disciplinary institutes for research and to create some permanent new facilities are likely to be initiated during this period. Several scientific seminars—at national and international levels—are also being planned during the Jubilee year.

The two science college buildings were tastefully decorated (spin-offs by way of a facelift have been welcomed by all) and the weeklong programme started off with an inaugural function on March 27 in the auditorium of the Saha Institute of Nuclear Physics (SINP). Benoy Kumar Chauduri, Minister-in-Charge of Land and Land Reforms, West Bengal gave the inaugural address, while some inspiring and thought-provoking remarks were made by A. P. Mitra, Director General, CSIR (present as the Chief Guest on the occasion) and by our Vice-Chancellor. B. D. Nagchoudhury presided over the afternoon seminar on 'Development of Science and Technology - Role of Universities'. P. K. Bose, A. P. Mitra, R. K. Poddar, M. M. Chakraborty, G. K. Manna and A. M. Ghosh discussed various facets of the subject.

Colourful exhibitions hurriedly organised by enthusiasts, an alumni get-together marked by encouraging as well as enlivening reminiscences, essay competitions among students on themes chosen by the different departments and a programme involving young researchers presenting their selected works formed parts of the programme. Presentations by teachers and research workers below the age of 35 of their selected works were organised in six groups for each of which a panel of at least three judges was constituted. These were mathematical sciences, physical sciences, biological sciences, social sciences, agriculture and technology.

On March 31, a seminar on 'Frontiers of Sciences' was attended by a packed audience in the SINP auditorium. Presiding over the seminar, Yash Pal, Chairman of the U. G. C., gave an enthralling account of some recent findings in space science besides making some epistemological remarks on 'frontiers' and 'thrust areas' in S & T. S. K. Lahiri of the CGCRI spoke on superconducting materials, J. K. Ghosh of the ISI highlighted some priority areas for statistical research, A. Bagchi of the IIMC explained the utility of artificial intelligence in solving a cutting stock problem, B.K. Sinha of the VECC gave a fascinating talk on cosmology, A. K. Sharma of our University gave a comprehensive account of gene sequences and D. Banerjee of Escon talked on some applications of S & T knowledge in plastic and rubber industries.

The concluding function was organised in the afternoon of March 31, T. V. Rajeswar, Chancellor of the University, paying his maiden visit to any university campus, spoke highly of the contributions of our university in the fields of S & T. He, however, expressed some personal reservations about the way S & T activity is organised in the country. Yash Pal gave away prizes to the young scientists whose presentations were adjudged the best in their respective groups as also to the students whose essays were rated the best in their respective departments. Heads of three departments viz. Marine Science, Statistics and Plastic & Rubber Technology received certificates in appreciation of the fact that exhibitions put up by those departments were assigned ranks 1, 2 and 3 respectively. □

BLOOD GROUPS AND CANCER

RANAJIT SEN*

SINCE the discovery of human ABO blood groups by Landsteiner[1], efforts are made to relate diseases with blood groups. The pioneers who realised the possible importance of blood groups and diseases and to carry out extensive blood grouping of patients were Buchanon and Higley[2] and they determined the ABO blood groups of 2446 patients suffering from a wide variety of diseases. Alexander[3] first reported 50 cases of malignant growths distributed in ABO blood groups and concluded that blood groups B and AB were susceptible to various forms of neoplasms and that group O was more stable and resistant. He observed also that O and A blood group individuals even if got malignancy, it took long duration to develop and was of low malignancy, while those occurring in groups B and AB were rapidly growing ones. Johnannsen[4] while examining blood groups in a series of 263 cases of various malignant growths found A and AB were more susceptible, while those in groups B and O were relatively resistant to various carcinogens. Goldfedar and Fershing[5] showed a diminished Group A and increased Group B and AB incidence in 300 cases in different sites. Gupta[6], Majupuria and Gupta[7] and Mitra *et al.*[8] in their extensive study showed relation of blood group with cancer in uterine cervix. Majupuria *et al.*[9] and Mitra[10] showed the relationship of blood group with breast carcinoma.

Aird *et al.*[11, 12] demonstrated convincingly the association between ABO blood groups and disease (between carcinoma of the stomach and blood group A). In recent years, the antigenicity of neoplasms has become a major preoccupation of oncologists and in this connection, the association of carcinomas and especially that of stomach, with group A has received repeated attention leading to the suggestion that an A-like antigen is present in human tissues, irrespective of the blood group of the patient. According to Hakomori *et al.*[13] the biosynthesis of blood group substances in gastric carcinoma tissue is incomplete and leads to accumulation in the tissue of a substance immunologically related to blood group A. Hakkinen and Virtanen[14] extracted a similiar substance from the cancer tissue while Kosciclax *et al.*[15] found an antibody in the blood of a group B patient with cancer of the lung, which was active both against A cells and against cancer cells. The antibody disappeared following preumonectomy but reappeared when secondary growths developed.

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*Chittaranjan Cancer Hospital, Calcutta

The search for possible association between neoplasms (benign and malignant) and blood groups has remained one of the most important area of research.

There are many reports on cancer from different parts of India[6-12, 16-20] but remained unexplored in eastern and north eastern India. Chittaranjan Cancer Hospital, Calcutta which is the oldest cancer hospital in eastern and north-eastern India receives patients from the two regions mainly. Being encouraged by this opportunity to study the said population, a survey is made on the blood groups of cancer patients admitted in Chittaranjan Cancer Hospital, Calcutta, to know the level of blood groups and to compare with those of other countries.

The blood of cancer patients admitted in Chittaranjan Cancer Hospital, Calcutta from 1980 to 1986 was grouped in the blood bank of the said hospital for the purpose of specific therapy when indicated.

The control group includes blood donors in different rural and urban blood donation camps of West Bengal, organised by different organisations and collected by blood bank staffs of Chittaranjan Cancer Hospital, Calcutta from 1980 to 1986. The blood samples were collected at random provided individuals were found medically fit.

In total 2908 normal subjects and 2168 cancer patients were evaluated.

The record of blood donors reveals that B blood group individuals are more prevalent (36%) (Table 1) over other groups and AB being the lowest. Distribution of ABO blood groups of the patients as per sitewise incidence of cancer can be conveniently divided into 6 categories as presented in Table 1. It was found that in all the groups incidence of B was highest followed by A group (Table 2). Out of 2168 patients studied at random, oral cancer patients were more (33.86%) than other groups of cancer and excretory organs were afflicted least.

In oral and alimentary canal cancer, B blood group shows more prevalence over other groups, while in respiratory, excretory, reproductive and miscellaneous groups A variety shows dominance over other groups (Table 2).

Again while analysing the relative values of O, A and B, the relative value of O : A is higher in case of oral carcinoma and it is lowest in the miscellaneous group (Table 3). Again O : B value is highest in oral, excretory and alimentary canal cancer and lowest in the miscellaneous group.

The O : AB value is highest in oral cancer while it is lowest in alimentary canal cancer.

TABLE 1 : Distribution of ABO blood groups in cancer at different organs

Cancer at the different organs	Blood Groups										Grand Total
	O		A		B		AB		Total		
	M	F	M	F	M	F	M	F	M	F	
1. Oral & Oropharynx											
Cheek	23	23	23	10	37	37	24	21	107	83	190
Lip	5	3	12	6	7	1	5	7	29	17	46
Tongue	23	13	5	10	19	11	11	8	58	47	105
Palate	6	5	6	20	17	4	9	5	38	37	75
Alveolus	9	13	19	5	16	15	6	3	50	36	86
Maxilla	22	8	12	3	17	14	6	6	57	31	88
Parotid	3	14	2	0	7	11	11	0	23	25	48
Tonsil	40	4	7	6	12	6	12	9	71	25	96
Total	131	83	86	60	132	99	84	59	433	301	734
2 Alimentary Canal											
Oesophagus	13	0	7	0	4	12	13	7	37	19	56
Stomach	16	4	5	4	6	9	5	0	32	17	49
Hepatopancreas	7	0	5	7	1	13	4	0	17	20	37
Gall Bladder	3	12	4	3	19	9	5	2	31	26	57
Intestine	14	0	3	0	2	4	6	6	25	10	35
Rectum	12	9	17	0	15	14	9	9	52	32	84
Anus	0	4	0	16	11	0	2	1	13	21	34
Total	65	29	41	30	57	61	44	25	207	145	352
3. Respiratory Organs											
Laryngopharynx	13	12	4	0	23	11	2	0	42	23	65
Bronchogenic	9	3	65	15	22	5	9	3	105	26	131
Total	22	15	69	15	45	16	11	3	147	49	196
4. Excretory Organs											
Kidney	11	7	3	8	4	2	7	1	25	18	43
Urinary Bladder	1	2	4	2	7	10	11	7	23	21	44
Total	12	9	7	10	11	12	18	8	48	39	87
5. Reproductive Organs											
Uterus	—	65	—	27	—	28	—	7	—	127	127
Cervix	—	13	—	43	—	154	—	15	—	225	225
Ovary	—	10	—	19	—	33	—	14	—	76	76
Testis	5	—	12	—	20	—	13	—	50	—	50
Total	5	88	12	101	20	215	13	36	50	428	478
6 Miscellaneous											
Breast	—	37	—	17	—	26	—	21	—	101	101
Euguis Sarcoma	2	2	15	10	24	10	3	0	44	22	66
Thyroid	1	3	5	4	10	2	6	9	22	18	40
Leukaemia	12	0	7	5	2	16	3	7	24	28	52
Malignant melanoma	1	3	1	0	4	1	4	2	10	6	16
Osteosarcoma	0	3	5	10	13	6	6	3	24	22	46
Total	16	48	33	46	53	61	22	42	124	197	321
Grand Total	251	272	344	166	316	454	192	173	1009	1159	2168

TABLE 2 : Distribution of ABO blood groups among the Patients according to the site of their affection

Site	Sex	Blood Groups				Total	Grand Total (%)
		O	A	B	AB		
1. Oral	Male	131	86	132	84	433	
	(%)	(30.25)	(19.86)	(30.49)	(19.40)	(59)	
	Female	83	60	99	59	301	
	(%)	(27.57)	(23.25)	(29.57)	(19.60)	(41)	
Total		214	146	231	143		734
(%)		(57.82)	(43.12)	(60.06)	(39)		(33.86)
2. Alimentary Canal	Male	65	41	57	44	207	
	(%)	(31.40)	(20.77)	(26.58)	(21.25)	(58.81)	
	Female	29	30	61	25	145	
	(%)	(30.85)	(41.10)	(5.259)	(36.23)	(41.19)	
Total		94	71	118	69		352
(%)		(26.70)	(20.74)	(32.96)	(19.60)		(16.23)
3. Respiratory Organs	Male	22	69	45	11	147	
	(%)	(14.96)	(46.94)	(30.61)	(7.49)	(75)	
	Female	15	15	16	3	49	
	(%)	(30.61)	(30.61)	(32.65)	(6.13)	(25)	
Total		37	84	61	14		196
(%)		(18.88)	(82.86)	(31.12)	(7.14)		(9.04)
4. Excretory Organs	Male	12	7	11	18	48	
	(%)	(25)	(14.58)	(22.92)	(37.5)	(55.17)	
	Female	9	10	12	8	39	
	(%)	(23.07)	(25.64)	(30.77)	(20.52)	(44.83)	
Total		21	17	23	26		87
(%)		(24.14)	(19.54)	(26.44)	(29.88)		(4.01)
5. Reproductive Organs	Male	5	12	20	13	50	
	(%)	(10)	(24)	(40)	(26)	(10.46)	
	Female	88	101	203	36	428	
	(%)	(20.56)	(23.60)	(47.43)	(8.41)	(89.54)	
Total		93	113	223	49		478
(%)		(19.45)	(23.64)	(46.66)	(10.25)		(22.05)

TABLE 2 *(Contd.)*

Site	Sex	Blood Groups				Total	Grand Total (%)
		O	A	B	AB		
6. Miscellaneous	Male	16	33	53	22	124	
	(%)	(12.90)	(26.61)	(42.74)	(17.45)	(38 63)	
	Female	48	46	61	42	197	
	(%)	(24 36)	(23.36)	(30 96)	(21.32)	(61 37)	
Total		64	79	114	64		321
(%)		(19.94)	(24.61)	(35 51)	(19.94)		(14 81)
Grand total (%)		523	510	770	365		2168
		(24.13)	(23.52)	(35.52)	(16.83)		
	Male	48%	67.45%	52.60%	52.60%		46.54
	Female	52%	32.55%	47.40 %	47.40%		53.46

TABLE 3 : Comparison between cancer and control blood groups as per sites

Sites	Total	Blood Groups					
		O	A	B	AB	O . A	O : B
Control	2908	973	676	1047	212		
(%)		(33.45)	(23.24)	(36)	(7.29)		
Oral Cancer	734	214	146	231	143	1 04	0.96
(%)		(29.15)	(19.89)	(31 48)	(19.48)		
Alimentary canal cancer (%)	352	94	71	118	69	1.11	1.14
		(26.70)	(20.17)	(33.52)	(19.61)		
Respiratory	196	37	84	61	14	3 26	1 53
(%)		(18.88)	(42.86)	(31.12)	(7.14)		
Excretory	87	21	17	23	26	1 16	1.01
(%)		(24.14)	(19.54)	(26.44)	(29.88)		
Reproductive	478	93	113	223	49	1.74	2 22
(%)		(19.45)	(23.64)	(46.66)	(10.25)		
Miscellaneous	321	64 (19.94)	79 (24.61)	114 (35.52)	64 (19 93)	1.77	1.65
	Total	1496	1186	1817	577		
	(%)	(29.47)	(23.37)	(35.80)	(11.36)		

While analysing the Gene frequencies in ABO blood groups, A and B gene frequencies in cancer patients are higher than those of control, while O frequencies are lower in cancer patients (Tables 4 & 5).

Among ABO blood groups, B blood group is found to dominate over other blood groups and AB is in the lowest scale. Out of 8 sites of oral cancer cheek carcinoma shows more B group subjects than other groups, unlike Mourant *et al.*[21] who observed more A blood group patients in cheek, gum, tongue and lip carcinoma. Mital and Gupta[16], Joyant[17], Ghooi *et al.*[18] however agree with our findings. In lip carcinoma, A group shows more prevalence over other groups as observed by Mourant *et al.*[21] and Hartman and Staven[22]. In tongue carcinoma O group dominates while in palate carcinoma A group supercedes other groups. In carcinoma of alveolus B group dominates which tallies with the findings of Mital and Gupta[16] and Tyagi *et al.*[19]. So the overall observation on oral cancer is B group dominates over other counterparts and AB being the lowest one. Males dominate this oral population.

In all other sites of cancer also B group is found to play a significant role. The other groups in succession are O, A and AB. While considering the sexwise incidence of cancer except the reproductive site males supercede females. As in cancer of the reproductive organs females dominate over males, females are encountered more in cancer.

TABLE 4 : Classification of data as per cancer sites

Blood	Total	Blood Groups								
		O	A	B	AB	p	q	r	O · A	O : B
Control (%)	2908	973 (33 47)	676 (23 24)	1047 (36)	212 (07.29)	0 1673	0.2479	0 5847		
Cancer (%)	2168	523 (24.13)	510 (23 52)	770 (35.52)	365 (16 83)	0 2244	0.3054	0 4701	1.40	1.37

TABLE 5 : Homogeneity X^2 for different sites of cancer

Site of cancer	d.f.	Value
1. Total cases	3	136 58*
2. Oral	3	99.48*
3. Alimentary canal	3	61.24*
4. Respiratory organs	3	193.84*
5. Excretory organs	3	58.84*
6 Reproductive	3	24.06
7. Miscellaneous	3	70.53*

Considering the overall incidence of cancer B blood group subjects are more prone to cancer than other groups and AB being the least affected group and males dominate females in all groups except cancer in the reproductive organs.

However other authors differ to some extent. In case of carcinoma in tonsil, oropharynx and hypo pharynx B blood group patients are more prone than other groups[21]. In salivary gland carcinoma however both A and B blood group are almost equally prone to affection. The same is true in case of carcinoma of oesophagus. The relative incidence of A/O and B/O in case of carcinoma of oesophagus are 1.10 and 1.29 respectively[21]. Here a closer association with B than with A is unusual. In case of carcinoma stomach, A/O and B/O relative incidences are 1.21 and 1.04. In case of large intestine the said values are 1.08 and 0.99 respectively. In case of carcinoma of liver, gall bladder, bile duct, pancreas A and B blood group subjects are more prone. In carcinoma of female reproductive organs A and B subjects are almostly equally affected.

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Nobel Prizes : 1988

PHYSICS

THE Nobel Prize in physics, this year, has been awarded to three physicists, Leon Lederman, Melvin Schwartz and Jack Steinberger who working together, more than twenty five years ago, discovered that muon has its own private neutrino ν . The discovery not only provided a fundamental piece of information in the development of the currently standard model of the elementary particles but also opened up new pathways to experimentally study weak interactions at high energies.

When the original stipulation of the donor that awards be made for work done 'during the preceding year' was set aside by the first Selection Committee which felt that it often takes years to establish the value of a contribution to physics. Einstein had to wait almost 15 years before he was nominated. But it may be a record that winners of this year had to wait more than twenty five years. The Royal Swedish Academy of Sciences awarded then jointly $ 390,000 prize "for the neutrino beam method and the demonstration of the doublet structure of the leptons through the discovery of the muon neutrino".

In early 1960s all the three were physics professors at Columbia University where they carried out this first neutrino beam experiment at Brookhaven's newly installed Alternating Gradient Synchrotron. The experiment was completed in June 1962.

Presently Lederman is the Director of Fermi National Accelerator Laboratory ; Steinberger is a senior physicist at CERW and professor at the Scuole Normale Superiore′ in Pisa ; and Schwatz who left the academic world in 1979 to become a full time enterpreneur, is President of Digital Pathway, a computer communications firm in Mountain View, California.

Birth of the idea :

Columbia's Pupin Laboratory is a place where many new ideas in physics have taken birth and it has a proud record of producing a number of Nobel Laureates. Thus in the present case too all began during an afternoon coffee hour in the laboratory in November 1959 when T. D. Lee (the then new Nobel Laureate of Columbia) threw down a challenge regarding weak interactions and Schwartz took it up. Our knowledge about weak interactions until then was through decay products and the energies involved were not too high. Even in the case of pion, muon and strange particles decays the energies were of the order of a few hundred MeV only. Lee showed on the black board, that afternoon that though Fermi theory works well at lower energies, it violated unitarity at higher energies. Thus if the energy of the weak interactions could be enhanced in the experiments, it might be possible to see intermediate bosons, two neutrinos and so on. Lee looked questioningly at his experimentalist friends and suggested that one could begin at a scattering experiment where weak interaction was masked by much stronger forces.

Thinking deeply on the problem, that night itself, Schwartz hit upon a solution which was to use neutrinos interaction to study weak interaction. The argument was, because neutrinos are uncharged leptons, impervious to electromagnetic and nuclear forces these immensely stronger forces would not confuse the weak scattering of neutrinos by nucleons. As no accelerator as such was available at the time and a proper detector to detect the events was decided upon, yet Schwartz wrote no paper for *Physical Review Letters* on this thought experiment within a few days. But he waited for a few months for a companion piece from Lee & Yang and the two were published together.

Around that time the alternating gradient synchrotron (AGS) a successor to the cosmotron, was just getting ready. According to Schwartz the intensity of the proton beam circulating in AGS would be inadequate for performing his experiments. However, at Lederman's encouragement a proposal was submitted in May 1960 to do a neutrino beam experiment at Brookhaven.

The Experiment :

Lee and Yang's companion paper to Schwartz's in the *Physical Review Letters* concluded that any remedy for the high energy unitarity problem of the Fermi theory, as they demonstrated, yields too high a rate of neutrinoless muon decay, unless muon neutrinos are different from electron neutrinos.

Lederman, Schwartz and Steinberger set out to prove or disprove the above conjecture with their high energy neutrino beam. If there are two different neutrino species labeled ν_μ and ν_e, a neutrino beam produced by the decay of pions would consist entirely of muon neutrinos and their antineutrinos. The muon neutrinos in their rare scattering events with protons and neutrons would produce only muons—never electrons or positrons. On the other hand, if there is no difference between muon—neutrinos and beta-decay neutrinos, the neutrinos interacting in the detector would produce equal numbers of muons and electrons (or positrons).

A ten ton spark chamber was made ready as detector by the time AGS began operation in the Summer of 1961. The AGS was delivering more than 10^{11} protons per second—much better than was expected. Even though AGS was giving 30 GeV protons, the Columbia group kept it at 15 GeV so as to prevent energetic muons from reaching the spark chamber. The Columbia group was joined by a couple of graduate students, one amongst them was an Indian—Nariman Mistry.

The 15 GeV circulating proton beam was repeatedly directed at a beryllium target in the AGS, where it created a profusion of pions and other hadronic debris, the charged pions emerging in the direction of the detector were typically of a few GeV of energy. In eight months of episodic running the estimated 10^{14} neutrinos that passed through the ten ton spark chamber yielded only 56 recorded events that looked like neutrino collisions. All 56 showed a collision producing a muon rather than electron. The experimenters had already seen the paths of electrons in the spark chamber by using the 400 MeV electron beam at the cosmotron. The electrons almost invariably generated tagged multi-particle showers, easily distinguishable from the clean, straight single tracks of their much heavier muon cousins. Thus the two neutrino conjecture had been convincingly confirmed. A year after the Brookhaven experiment CERN confirmed the results with higher statistics. Today the same number (10^{17}) of 1000 GeV protons from the Fermi Tevatron can yield almost a million neutrino events (instead of 51). A third lepton—the tau has also been discovered and its own neutrino also is assumed. Further, it is expected that these neutrinos may even have non-vanishing masses.

In his undergraduate at Chicago University Steinberger was a major in Chemistry. Joined army in 1942 after graduation. He joined MIT, after his service, where his serious interest in physics developed. He completed his experimental thesis with Fermi in 1948 and spent a year at Princeton, Institute of Advanced Studies. From there he spent a year at Berkeley and later joined Columbia. During this period he went on several sebbaticals at CERN and permanently moved there in 1968.

Schwartz is a product of Columbia Physics department, undergraduate degree 1953, graduation 1958. From then on he was on the faculty until 1968 when he moved to Stanford.

Like Steinberger, Lederman also graduated in Chemistry from City College. New York in 1943. As a graduate student he worked at the Nevis Laboratory of Columbia University with a cloud chamber under the guidance of a visiting professor Gilberto Bernardine of Rome University. He joined the faculty of Columbia University in 1951 and was the director of the Nevis Laboratory from 1962 to 1979 when he left for Fermi Laboratory. □

B. B. Baliga

CHEMISTRY

THE 1988 Nobel Prize in Chemistry went to three German scientists who presented for the first time the three-dimensional structure of a protein-pigment complex which performs the key role in driving Nature's engine for photosynthesis which converts sunlight into energy. The three scientists are : Robert Huber, 51, of the Max Planck Institute for Biochemistry in Martinsried, West Germany ; Johann Deisenhofer, 45, presently at the Howard Hughes Medical Institute in Dallas, Texas, USA ; and Hartmut Michel, 40, of the Max Planck Institute for Biophysics in Frankfurt, West Germany.

Photosynthesis starts when chlorophyll from nature's storehouse absorbs a photon. This leads to quick charge transfer from a donor to an acceptor and this charge transfer ultimately forms the high energy compound called, adenosine triphosphate or ATP. The chemical compound which performs the key role in inducing this charge separation, comprises a protein-pigment complex which in general is called the photosynthetic reaction centre.

Delineation of the physical structure of this reaction centre was once considered a formidable task. The first hurdle in this task was to isolate the reaction centre from the membrane bound form and subsequently crystallize it. In 1980 Michel and others thought of using suitable detergents which can dissolve out the membrane. Like proteins detergents are also amphiphilic in nature. Hence ultimately the protein freed from the membrane but encaged in the detergent may be isolated. Subsequently the protein including the detergent can be purified and crystallized. Proceeding in this way Michel tried to isolate the reaction centre from the bacterium Rhodopseudomonas viridis and ultimately in 1982 he succeeded in isolating and crystallizing it out in the form of pure large crystals.

In order to find out the crystal structure of the isolated reaction centre Michel the collaborated with Deisenhofer of the strong crystallographic group at the Max Planck Institute at Martinsried where Huber was the leader of the group. It took about two years to solve the complete structural problem and in 1985 they could depict a full picture of the structural details of the reaction centre. This is the first instance that the structure of a membrane bound protein has been delineated with a resolution of three angstroms. This has provided a strong fillip in studying reaction centres present in other bacteria. Adornment of these scientists with Nobel Prize, is in fact a recognition of two things : one, development of an ingenious chemical method of isolating, purifying and crystallizing a membrane bound protein and second, delineation of the three dimensional structure of such a complex molecule which has in its framework several thousand atoms.

The reaction centre is found to be composed of four protein subunits along which are arrayed two chains of pigment molecules. The electron transfer is believed to occur along these chains. The two chains are crystallographically found to be nearly identical but it is surprising that electron transfer occurs preferentially along only one of the two chains. Besides this, there are many other intriguing problems which are still posing challenges to the present day researchers. Nevertheless, this discovery will have a large impact on various aspects in chemistry, biology, agriculture, etc. It is really tempting to think that it may not be very far off when scientists will be able to design solar cells which mimic the nature's process of photosynthesis. □

S. N. Bhattacharyya

PHYSIOLOGY OR MEDICINE

THE 1988 Nobel Prize for Physiology or Medicine has been awarded to the two American scientists and a British scientist for their major contributions on drug development in modern medicine. The American scientists, George H. Hitchings (83) and Gertrude B. Elion (70) did their most important discoveries at the Wellcome Research Laboratory of Burroughs Wellcome Company in Research Triangle Park, North Carolina, USA and the British scientist, Sir James Black (64) did most of his pioneering work in drug development in England for the Smith Kline Beckman Corporation and the Imperial Chemical Industries. While honouring these scientists with this highest distinction, the Nobel Committee at the Karolinska Institute in Stockholm specially noted that the work of the three scientists has made a new breakthrough to the drug-hunting approach : "While drug development, in earlier years, had mainly been built on chemical modifications of natural products, these scientists have introduced a more rational approach based on the understanding of basic cell biochemistry and cell physiology".

Starting their work more than 40 years ago, George Hitchings and Gertrude Elion made their major thrust for drug-hunting research, by interfering with the DNA synthesis in cancer cells using different analogues of nucleic-acid components. One of the first drugs, synthesized by Hitchings was 2 : 6 diaminopurine (DAP), which was found to have some potential DNA inhibitory activities. In collaboration with Gertude Elion, Hitchings developed another type of potential anti-leukaemia drugs, 6-mercaptopurine and another analogue of thioguanine which were approved for clinical treatment. More recently in 1977, they discovered the drug, acyclovir, the first effective drug in the treatment of herpes virus infections. Further continuation of their study, based on the philosophy of "illustrated empiricism" to quote the expression coined by Hitchings, gave birth to a novel series of drugs like allopurinol, a useful drug in the treatment of gout caused by high uric acid, pyrimethamine (or Daraprin) for malaria and trimethoprim (or Bactrim) for urinary and respiratory tract infection etc.

The drugs developed by Sir James Black are mostly based on focussing receptor molecules on the cell-membrane surface as the target site for drug action. Sir James discovered two important groups of drugs. The first group is the beta-blockers, which are well-known for use in the treatment of high-blood pressure and different types of heart diseases. The chemical name of the drug is propanolol which is sold under the brand name 'Inderal' all over the world. Propanolol or beta-blocker group of drugs decreases the heart-muscle contraction rate by locking the receptor molecule of noradrenaline like chemicals which are highly elevated in people suffering for high-blood pressure. After the successful innovation of the beta-blocker group of drugs, in early sixties, Sir James became interested in designing potent anti-ulcer drugs. Since histamine was one of the factors responsible for high gastric acid secretion, after synthesizing a series of anti-histaminic compounds, Sir James was able to discover a highly specific histamine antagonist, cimetidine, which is specifically active for gastric-histamine receptor, known as H_2. In this way, cimetidine was born and this drug is still the No. 1 drug in gastric-ulcer therapy.

By awarding this year's Nobel Prize to Hitchings, Elion and Black the Nobel Committee has, no doubt, given a special recognition to the development of drugs which are effective in combating mankind's most serious diseases in the world. □

J. J. Ghosh

OBITUARY

B. C. KUNDU

(1905-1989)

Dr. Balai Chand Kundu, an eminent botanist, a world authority on jute cultivation and particularly a renowned plant anatonist, passed away on 22nd January, 1989 in his Calcutta residence.

Dr. Kundu was born on 18th April, 1905 at Jaynagar near Calcutta. After having a successful early education, he graduated from the Bangabasi College, Calcutta and later passed the M. A. examination in Botany from the University of Calcutta with a first class. Dr. Kundu then briefly served the Rajsahi College (now in Bangladesh). At this juncture, he went to U. K., joined the University of Leeds for higher studies and obtained Ph.D. degree working under the celebrated guidance of Prof. R. D Preston. After his return from abroad he joined the Botany Department, Presidency College and eventually became Professor of Botany there. His persistent effort had enabled him to develop a well reputed school of research in plant anatomy and taxonomy of higher plants in the Presidency College.

Dr. Kundu's valuable research contributions in the form of original papers published in many national and international journals were acclaimed as of high quality pertaining to fundamental and applied branches of Botany, mainly dealing with jute anatomy, breeding and agriculture.

After having a successful teaching career he accepted a challenge by taking up the charge of Jute Agricultural Research Institute at Dhaka under the management of Indian Central Jute Committee. This was the point when India gained freedom and when the country was divided. Dr. Kundu's far reaching vision and painstaking planning gave birth to an Institute in the same name, i.e. Jute Agricultural Research Institute at Barrackpore near Calcutta under Indian Council of Agricultural Research and he became the first Director. The extension and research activities were reorganised under his able guidance and leadership to foster jute and allied fibre-crop cultivation in India employing the latest research perspectives. He retired from this Institute in 1960. His long acquired experience and knowledge in Jute cultivation resulted into a book, "Jute in India", by him co-authored with P. B. Sarkar and K. C. Basak, which probably is the only monograph available on jute agriculture, technology and marketing in India.

After his retirement from the JARI he served the Central Drug Research Institute, Lucknow for some time as Deputy Director ; the Bose Institute, Calcutta as Joint Director ; and finally as Emeritus Scientist at the Botanical Survey of India. The undersigned had the privilege of coming into his close contact during the period of his service at the Bose Institute when, in addition to his responsibilities as Joint Director, he also looked after the administrative and research activities of the Botany Department.

His academic distinction brought him many awards and honours at different times : he was elected a Fellow of the Indian National Science Academy ; recipient of Rafi Ahmed Kidwai award (Indian Council of Agricultural Research) ; Dr. Brühl Medal (Asiatic Society) ; President of the Botany Section (Indian Science Congress Association) ; Fellow of the Linnean Society of London ; President, Botanical Society of Bengal, Calcutta ; Vice-President, Asiatic Society, Calcutta ; Vice-President, Indian Science News Association, Calcutta and so on.

He widely travelled in India and abroad as an expert in jute and jute-based cropping systems. Dr. Kundu attended the International Botanical Congress, Seattle, U. S. A. as an Indian delegate.

Dr. Kundu was actively associated with many scientific and voluntary organizations and also with various philanthropic and charitable trusts.

Dr. Kundu's personality was unified in the form of a sound researcher, an able administrator, a successful teacher, and as an amiable man. In his demise the country has lost a good scientist. He is survived by a son and three daughters. □

Sunirmal Chanda

Notes and news

Water problem with Bakreswar Plant

Recently, West Bengal Chief Minister laid the foundation for a 630/840 MW thermal power plant at Bakreswar. The state is determined to set up the plant even at the cost of blood, if required. For Bakreswar, there can be no want of a blood but it is water that poses problem.

For the thermal plant like coal, water is also an essential input. While land, coal do not pose a problem, water does. It was initially decided that the 30 cusecks which the Irrigation Department had promised would be drawn from the Mayurakshi system. But way back in around 1983, it was revealed that water from this source would be insufficient even for nine months. This 30 cusecks of water assured by the Irrigation Department also will not be able for even full operation of two 210 MW units for nine months, it is revealed.

Obviously, attention was drawn to Bakreswar reservoir for the rest three months. But it is speculated that in the drought-prone area, there would not be enough water every year.

Next comes the question of using ground-water and the surface-water. Planners have revealed that areas like Panagarh have abundant groundwater. It was proposed to avail of surface-water from Ajay river and others. But none is dependable. For a lack of a national policy on water utilisation, dearth of water hits the industries by and large.

These days ground-water scarcity is too much particularly at the drought period. Although oil from underneath can be fully pumped out, water cannot be. Underground aquifers which maintain a balance between sea water and other surface-water is disturbed if too much water is withdrawn. It is because a kind of vacuum is created within for which water withdrawn from the underground aquifers has become too difficult.

For the availability of surface-water, constructions of dams will be needed. The cost has become one problem ; the displacement of people from the area and rehabilitation of the displaced people will be another. Over and above, it has association with the environmental problem.

During drought time, the scarcity becomes intense. Water becomes saline. It is unfit for industrial applications. The boilers may then crack. However, water table depth may be disallowed to go down by the rationed withdrawal and by artificial recharge schemes. It is reported that Tamil Nadu and Gujrat governments have contemplated artificial recharge schemes to arrest decline of ground-water table and prevent salinity incursions. Combined use of ground-water and surface-water may help water scarcity to overcome. □

P. C. Bhattacharyya

Studies on Zooplankton with Special Reference to Biofouling from Offshore Region of Arabian Sea

K. Lakshmikantha Bhat, a CSIR research fellow at the National Institute of Oceanography (NIO), Goa, carried out studies on zooplankton with special reference to biofouling from the offshore region of Arabian Sea.

His thesis presents results of the study involving qualitative and quantitative aspects of zooplankton, abundance of planktonic larvae of fouling organisms in the natural environment and correlation of the same with the extent of settlement that has taken place on test panels and the biochemical composition of zooplankton in the offshore oil field of Bombay High. This work has added a new dimension to the studies on marine ecology, viz. ecology of the waters around offshore platforms. The salient features of the study are :

(1) The data on physico-chemical parameters indicate that the water column of Bombay High has distinct stratification. The formation of two layers, except during the period January to March, indicates that the area of investigation does not seem to be affected by the south-west monsoon conditions unlike coastal waters of Bombay. On the basis of physico-chemical parameters it seems more plausible that Bombay High is more influenced by northern Arabian Sea water than the coastal waters.

(2) The monthly values of zooplankton biomass exhibit great fluctuations. In general, the biomass values are relatively high during postmonsoon period with peak values in December/January. A maximum of 24 different groups were recorded, and copepods formed the major component of zooplankton community.

(3) The zooplankton biomass as well as their composition indicate that the area covered is of considerable organic productivity.

(4) Among the major fouling larvae, bivalve larvae form the major component in the plankton collections. The cirripede larvae, bryozoan larvae and the ascidian tadpole larvae are small in number and exhibit discontinuous pattern in their distributions.

(5) The observations on larval distribution reveal that there is a considerable potential for the onset of fouling in the area during January-February-March.

(6) The correlation between the larval abundance and their settlement on panels (aluminium and mild steel) is very meagre. Furthermore, though the larval forms of oysters and cirripedes are recorded from the plankton they are not significant quantitatively, as compared to the other groups of zooplankton.

(7) Studies on biochemical composition of zooplankton revealed that protein serves as a metabolic reserve. The zooplanktonic organisms of Bombay High area do not have extensive lipid and carbohydrate storage. The calorific value of zooplankton was found to be low which indicates that the energy available for plankton feeders such as marine fouling organisms is comparatively less. □

CSIR News

Technology of Production of Blue Green Alga *Spirulina platensis* and Its Application

A study made by Somasekaran at the Central Food Technological Research Institute (CFTRI), Mysore, details the development of appropriate technology for large scale production of *Spirulina platensis* to suit Indian conditions. The steps developed in cultivation and processing have been to reduce capital investment and energy inputs. Detailed studies were also made to evaluate the alga thus produced as a component of poultry feeds. Clean water system for algal cultivation was studied on a pilot plant scale in an area of 240 m^2. The highlights of the study are : a simplified nutrient combination 'CFTRI

Medium' was developed using agricultural fertilizers and commercial fertilizers with lower inputs of bicarbonate as a carbon source. Algal slurry was concentrated by gravity filtration and dried in sun into flakes without loss of nutrients. The system developed has minimal electrical energy inputs and cost intensive equipment and is suitable for adoption even in rural areas. Reproducible yield of 10-12 $g/m^2/d$ was obtained over a three-year period of study with algal material of good nutritional quality. The feasibility, cost economics and material balance of *Spirulina* production was also worked out.

The sun dried algal biomass contained 60-65% crude protein and 4-6% nucleic acid. Lipid content was 2-3% of which 20-30% of total fatty acids was accounted by gamma-linolenic acid (GLA). Total carbohydrates were 12-15% and ash content 8-10%, vitamin B-complex with cyanocobalamine, 2.4 mg/kg dry algae and carotenoids, 3.9 g/kg dry algae. *Spirulina* had higher amount of aspartic acid, glutamic acid, isoleucine and leucine compared to other algae with slightly lower amounts of sulphur amino acids. Sun drying did not lower the nutrient quality as compared to other methods of processing.

Extensive feeding trials carried out in a poultry farm with 200 birds in each experiment, over an 18 months period clearly showed that sun-dried *Spirulina* can successfully replace oilseed meal and fish meal. The elimination of vitamins and mineral mix in feeds with algae was also evaluated. In broilers (strain : Rani Shaver), a 12-week feeding showed that feed conversion ratio, growth performance and dressing percentage were comparable to commercial feeds. The dressed meat had deeper colour compared to control and was acceptable in sensory trials. In layers (strain : Hisex), a 72-week feeding trial, showed comparable growth on algal based experimental feeds and on the control feed. Feed conversion ratio, growth characteristics and dressed carcass weights were comparable in all groups. The egg yolk had a distinct intense orange colour in layers fed with algal feeds which was highly acceptable to the sensory test panel. Detailed toxicological studies of *Spirulina* fed birds did not reveal any serious abnormalities in histological, haematological, and biochemical studies.

This work has shown that the alga *Spirulina platensis*, can be produced by an appropriate technology suitable to Indian conditions which is applicable even at rural level. The algal biomass can effectively replace the conventional protein source in poultry feeds. This will be useful to integrate algal production with poultry farming, which is now a highly organized bio-industry in India. □

CSIR News

Studies on Xylanase from *Chainia* sp.

Only a few reports are available on hemicellulases from bacteria. A sclerotial actinomycete. *Chainia*, isolated from soil, produces a high amount of extracellular xylanase on xylan or xylan containing substrates. K. B. Bastawade of the Division of Biochemical Sciences, National Chemical Laboratory (NCL), Pune, purified the enzyme and confirmed its homogeneity by disc gel electrophoresis, SDS gel electrophoresis as well as by isoelectric focussing. Its molecular weight is 5500, which is the lowest among the xylanases reported so far. The enzyme showed lowest *k*m value for xyloheptaose (× 7) among xylooligosaccharides tested, suggesting that xyloheptaose is its natural substrate. The enzyme is an endotype xylanase cleaving the third β (1-4)-d- xylopyranose linkage from the non-reducing end which has been experimentally proved. End product analysis and the bond cleavage frequency data suggest that the xylanase has a large substrate binding site of 6 to 7 subsites at its active site.

The low molecular weight xylanase can find application in the paper industry owing to its non-celluloytic activity for the removal of xylan. Because of its small size it can penetrate into regions of cellulosic complexes which are inaccessible to other large molecular weight xylanases. ☐

CSIR News

Letters to the editor

Biological treatment of domestic waste-water by water-hyacinth and algal culture

In recent years, sewage and industrial effluents have been regarded as the most common sources of pollution. In Varanasi, about 126.58 million litre per day untreated city sewage mixed with industrial effluents generated by 7.97 lakh people is discharged into the river Ganga. During microbial decomposition, these substances show very high biochemical oxygen demand (BOD) and least dissolved oxygen (DO). Sometimes DO become zero which creates anaerobic condition and the receiving system becomes septic, emitting bad smell. Therefore, the aquatic fauna especially fish suffer. As such, untreated domestic sewage and industrial effluents cannot be used directly for irrigation purpose also. Thus, the treatment of domestic wastes is urgently needed.

Waste-water purifying capacity of water hyacinth has been studied by some workers[1-5]. In the present investigation, water hyacinth (*Eichhornia crassipes* (Mort.) Solms) which is a common aquatic weed and some algae, i.e., *Microcystis*, *Scenedesmus*, *Chlorella* and *Chlamydomonas* have been selected to evaluate their efficiency for the water purification.

Domestic waste water was collected from Rajghat nala and the same sewage was mixed well by mechanical agitators in the laboratory. Homogenised sewage was allowed to settle. Settled sewage were taken into the aspirator bottles and was allowed to flow through experimental tanks as shown in Fig. 1.

In water-hyacinth culture, various physico-chemical and biological parameters such as DO, BOD, chemical oxygen demand (COD), nitrate-N, phosphate-P, pH, total alkalinity and total coliform bacterial count have been analysed by methods described in APHA[6]. For this study, ten water-hyacinth plants were selected for the experiment. The pH and DO were analysed twice a day at 8.00 AM and 2.00 PM. Phytoplankton population was estimated by microtransect method[7] and zooplanktons by the method described by Jhingran *et. al.*[8]

The average data obtained over four months are given in Table 1. The present findings

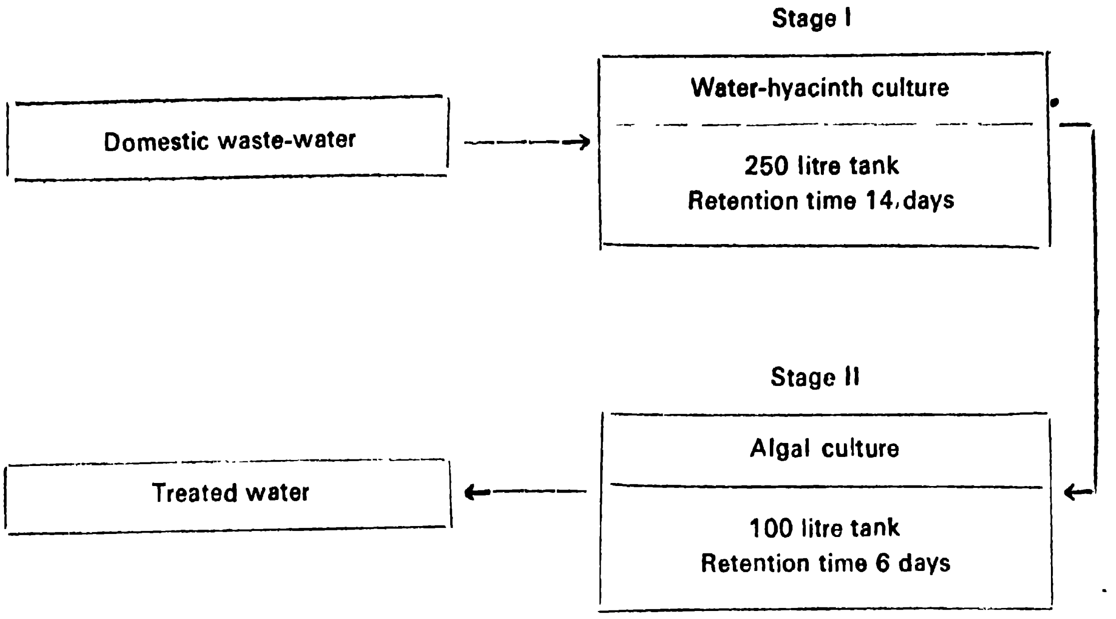

Fig. 1. Flow diagram of waste-water

TABLE 1 : Treatment of domestic waste-water by water-hyacinth and algal culture

Properties		Domestic waste-water	Water-hyacinth culture		Algal culture	
			14-day retention time	% Ruduction	6-day retention time	% Reduction
Dissolved Oxygen (mg/l)	8.0 A.M.	Nil	0.95	Nil	4.67	Nil
	2.0 P.M.	Nil	2.0	Nil	16.75	Nil
pH	8.0 A.M.	8.05	7.05	12.42	7.04	12.54
	2.0 P.M.	9.14	8.14	10.94	8.04	12.03
Biochemical Oxygen Demand (mg/l)		290.0	94.7	67.34	30.7	89.41
Chemical Oxygen Demand (mg/l)		570.0	370.5	35.0	290.0	49.12
Nitrate N (mg/l)		3.17	0.75	76.34	0.40	87.38
Phosphate P (mg/l)		12.7	3.45	72.83	1.05	91.73
Total Alkalinity as $CaCO_3$ (mg/l)		656.0	375.8	42.71	94.5	85,59
Total Coliform Bacterial Count/100 ml		15×10^5	1.98×10^5	86.8	0.53×10^6	96.47
Phytoplankton Density (individuals/l)		Nil	624×10^8	Nil	1465×10^4	Nil
Zooplanktons (individuals/l)		Nil	275	Nil	7934.5	Nil

reveal that during 14 days retention time. BOD value has been reduced from 290.0 mg/l to 94.7 mg/l, i.e. 67.34%. The reduction in other parameters such as COD by 35%, nitrite by 76.34%, phosphate-P by 72.83%, total alkalinity by 42.71%, and total coliform bacterial count by 86.8% have been observed. The pH value varied between 7.05 to 8.14. However, DO ranged from 0.95 mg/l to 2.0 mg/l. Phytoplankton density was 624×10^3 individuals/l and water quality of water-hyacinth culture was quite good and satisfactory within 14-day retention time. However, DO values were not sufficient. Owing to this reason algae were cultured at the second stage for further purification of water.

At the second stage of algal culture, further reduction in BOD by 89.41%, COD by 49.12%, nitrate-N by 87.38%, phosphate-P by 91.73%, total alkalinity by 85.59% and coliform bacteria by 96.47% were recorded during 6-days retention time only. DO content of water increased to 4.67 mg/l at 8.00 AM and 16.75 mg/l at 2.00 PM. However, pH was 7.04 at 8.00 AM and 8.04 at 2.00 PM. The maximum concentration of DO and pH was recorded at 2.00 PM due to high photosynthetic activity of algae. Zooplankton number was further increased from 275 individuals/l to 7934.5 individuals/l.

Thus, the present sewage-treatment experiment using water hyacinth and algal culture reveals that the sewage may be treated and a good quality of water may be obtained within 20-day retention time. This technique may be useful and can be adopted on a commercial scale.

Authors are thankful to Professor G. N. Choudhri and Professor H. D. Kumar for their valuable suggestions.

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Received : 16 August, 1988.
Revised : 19 December, 1988.

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Insecticidal effect of herniarin, a constituent of *Herniaria glabra* against the jute semi-looper *Anomis sabulifera*

Anomis sabulifera, commonly known as the Jute Semi-looper, is a serious pest of all varieties of jute. These green-coloured caterpillars can lead to complete defoliation and cause heavy loss of the yield of jute fibre. Work has been done to control this pest with synthetic insecticides, both organic and inorganic. However, reports on control of this pest with plant products is very meagre[1,2]. In view of the operational and residual hazards of the conventional synthetic insecticides, attention is being increasingly turned worldwide to the use of plant-products which lack these harmful side-effects. In this connection, we took up the present investigation to assess the effect of herniarin, a constituent of *Herniaria glabra*, against *Anomis sabulifera* under laboratory conditions.

Herniaria glabra (Fam. Illecebraceae) is a small herb growing in Europe, North Asia and India. It can thrive well in poor soil[3]. The plant is generally administered in the form of infusion in catarrhal affections of the bladder. The aqueous extract of the plant acts as a hand cleaner[4]. Herniarin, a reported constituent of *H. glabra*, has the structure of O-methyl umbelliferone (I). It can be prepared from umbelliferone by methylation.

Herniarin[5], $C_{10}H_8O_3$, was obtained from the plant *H. glabra* by extraction with methanol. The solvent was removed from the methanolic extract under reduced pressure and the residue was taken up in chloroform and chromatographed over silica gel. The compound was eluted in benzene and benzene-chloroform eluates, and crystallised as leaflets, m.p. 117-118°, from methanol.

Herniarin was dissolved in acetone and then diluted further by adding distilled water to eight different concentrations, e.g., 1%, 0.5%, 0.3%, 0.1%, 0.07%, 0.04%, 0.02% and 0.01%. All the concentrations were replicated four times and were tested in the laboratory against the larvae of *A. sabulifera* to assess their insecticidal effect through contact action. The larvae of *Anomis sabulifera* were reared in the laboratory. Eight such healthy last instar larvae of the same age were put in each petri dish for each concentration in each replication. One ml of each of the above-mentioned concentrations was sprayed directly on the larvae kept in the petri dishes with the help of Potter's Tower under 15 lb pressure. Heavy

TABLE 1 : Insecticidal effect of herniarin on the larvae of *A sabulifera*

Concentration	Mortality after 24 hr (%)		Mortality after 48 hr (%)	
	Mean Agular Value	Back transformed Value	Mean Agular Value	Back transformed Value
1%	90.00	100.00	90.00	100.00
0.5%	90.00	100.00	90.00	100.00
0.3%	90.00	100.00	90.00	100.00
0.1%	90.00	100.00	90.00	100.00
0.07%	72.14	90.59	90.00	100.00
0.04%	46.81	53.16	52.37	62.72
0.02%	15.00	6.69	27.67	21.57
0.01%	0.00	0.00	10.35	3.23
Control	0.00	0.00	0.00	0.00

SE (Mean) = 3.6285°   SE (Mean) = 2.3685°
C. D. at 5% = 10.52°   C. D. at 5% = 6.67°
C. D. at 1% = 14.22°   C. D. at 1% = 9.28°

knock-down effect on the larvae was observed immediately after spraying from 1% concentration of the compound to 0.1% concentration and most of the larvae died immediately after coming in contact with the spray-material and some other became motionless. After spraying, larvae were kept under fan for quick drying up of the spray material. In the control, acetone was sprayed directly on the larvae to ascertain its individual effect on the larvae. Fresh and undamaged leaves of JRO 632 thoroughly washed under tap were given in each petri dish for the food of the larvae. The larvae in both treated and control petri dish were covered with another petri dish so that no surviving larvae could move away. The records on the mortality of larvae were taken after 24 hr and 48 hr of spraying, 100% mortality of the larvae was observed from 1% to 0.1% concentration in 24 hr and after 48 hr. 100% mortality of the larvae was observed up to one minimum of 0.07% concentration. None of the larvae was observed to be killed in 48 hr in control. Data obtained on the mortality of the larvae from the observations after 24 hr and 48 hr have been presented in Table 1. Herniarin, a major constituent of the plant *Herniaria glabra*, possesses high insecticidal properties. Hence, further attempts will be made to control this pest under field conditions with herniarin, a compound obtained from *H. glabra*, to explore its feasibility for the use of farmers.

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Received : 12 September, 1988.
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A note on serum immunoglobulin levels in smokers and non-smokers of Madurai

Cigarette smoke modifies the immune response in all organs of mice[1] and tar and water-soluble fraction[2] of tobacco smoke contain certain substances which induce injury to lymphocytes of the living body. In man, both air pollution and cigarette smoking have been associated with an increased susceptibility to respiratory infections[3].

The effect of cigarette smoking on humoral immunity in man is less extensively studied[4,5] and the work on Indian population has been totally ignored. Hence, the present study was undertaken.

Twentyfive (20-40 years old) healthy normal males and twentyfive chain smokers (3 packets/day, for 5 years) of Madurai were selected and their serum immunoglobulin concentrations were examined using single radial immunodiffusion technique[6].

It was observed (Table 1 & Fig. 1) that the levels of IgG and IgA showed a significant ($P<0.05$) decrease of 18% and 27% respectively in smokers than in non-smokers. The IgM level decreased by 15% in smokers but the results were not statistically significant as observed in smokers of Japan[7]. But in the

TABLE 1 : Serum immunoglobulin levels in smokers and non-smokers

Serum Ig	Non-Smoker mg/dl	Smoker mg/dl	% Decrease	P. Value
IgG	1180 ± 112	973 ± 100	18	< 0.05
IgA	235 ± 42	149 ± 34	27	< 0.05
IgM	78 ± 15	66 + 12	15	Non-Significant

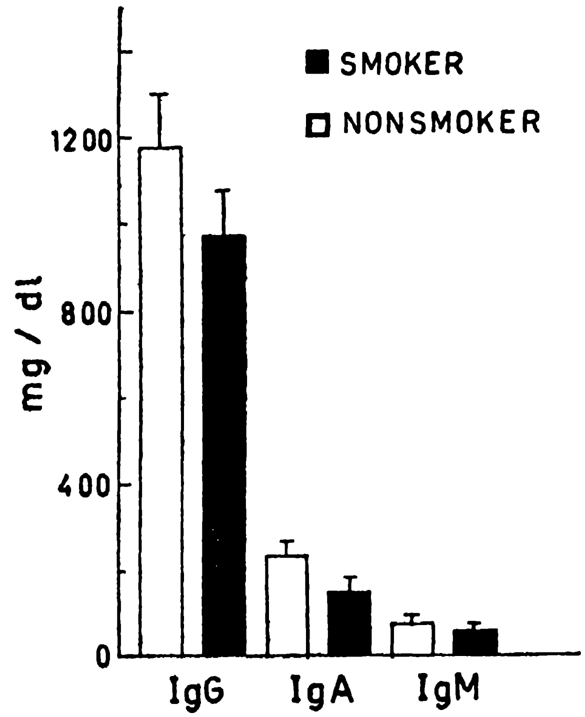

Fig. 1. Comparative Serum immunoglobulin levels in smokers and non-smokers of Madurai population

population of Oslo, the average immunosuppression level of IgG, IgA and IgM in smokers ranged between 9% and 12%.

Both nicotine and water-soluble fraction of cigarette smoke in man reduce the number of antibody producing cells and inhibit the transformation of peripheral lymphocytes[8]. But at present the mechanism of immune suppression due to smoking is not clearly known.

We are grateful to Dr. V.R. Muthukaruppan, Head of Immunology Dept., Madurai Kamaraj University and his colleagues for suggestions, Dr. Peter Jeyapandian, Principal, American College, for encouragement, Prof. A. Winfred and Dr. R. D. Michael for facilities and Dr. Chandra Mohan for donating blood samples.

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Weed control in puddle-seeded rice by some pre-emergence herbicides

The puddle-seeded system of rice culture is considered as an alternative transplated system, which is time-consuming and requires a large labour force for various operations, viz. raising seedlings, uprooting and transplanting. Besides, for the coverage of larger areas under rice in the dry season, this practice can well be adopted. However, it was reported[1,2] that weed competition during early stages of crop growth causes yield losses up to 37%. Since hand-weeding is costly and time-consuming, the use of herbicides as an alternative practice can be of considerable practical importance. Hence, the experimental hebicides developed from time to time need to be evaluated for their suitability in this system.

A field experiment was, therefore, conducted during 1984 dry season at Central Rice Research Institute, Cuttack to evaluate different pre-emergence heribicides and their methods of application, viz. broadcasting of EC/WP-sand mixture and granules for their performance in puddle-seeded rice. The herbicides included both commercially available and experimental compounds. Those were butachlor (N-butoxy-methyl-α-chloro-2′, 6′-diethylacetanilide), thiobencarb (S-4-chlorobenzyldiethyl thiocarbamate), oxadiazon [5-tert-butyl-3 (2, 4-dichloro-5-iso-propoxyphenyl)-1, 3, 4-oxadiazol-2-one], anilophos [S-(N-(4-chlorophenyl-)-N-isopropyl carbamoyl-methyl-)-o, o-dimethyl-dithiophosphate], fusilade (fluazifop-butyl), oxyfluorfen [2-chloro-1-(3)-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)] benzene, pendimethalin [N-(1-ethyl propyl)-3, 4-dimethyl-2, 6-dinitrobenzenamine] and three formulations of 2, 4-D (2, 4-dichlorophenoxyacetic acid)—slow release—lac-2, 4-D containing 17.7% a.i., 2, 4-D formulation containing 98% a.i., sodium salt of 2, 4-D with 80% a.i. Hand-weeded and unweeded checks were also included for comparison (Table 1). The design adopted was RBD with three replications. The test variety—Sattari (of 70 days duration) was broadcast sown with sprouted seeds @ 75 kg/ha on February 3. All the herbicides were applied one week after sowing in a thin film of water. In case of EC/WP-sand mix application, the liquid/powder formulations of herbicides were mixed with sand @ 25 kg/ha thoroughly and then broadcast.

Results (Table 1) indicated that the herbicides butachlor, thiobencarb, oxadiazon, anilophos and oxyfluorfen at the rates tested gave fair degree of weed control and thus improved the yield components—panicles and panicle weight—and yield of the crop over unweeded check substantially. The grain yield and yield components recorded with these treatments were comparable to hand-weeded check, which was given two rounds of hand-weeding. Generally, the EC-sand mix application of thiobencarb was comparable to granular application in terms of grain yield. In case of butachlor, this method was inferior to granular application, probably due to uneven spreading of the liquid in the field causing phytotoxicity to the emerged seedlings in patches. The experimental herbicides-fusilade, three formulations of 2, 4-D and pendimethalin were not comparable to hand-weeded check in controlling the weeds and improving the yield. The efficiency of granular herbicides in puddle-seeded rice was earlier reported by other workers.[1,3,4] Thus, by effectively controlling the weeds using pre-emergence herbicides,

TABLE 1 : Effect of different pre-emergence herbicides on weed control, yield components and yield of puddle-seeded rice

Herbicide	Rate of application (kg a.i./ha)	Method of application	Dry weight of weeds (kg/ha) at harvest	Phyto-toxicity rating (1-5 scale)	Panicles/m^2 (transformed values)	Panicle wt (gm)	Grain yield (t/ha)
Butachlor	0.75	Granules	93	1.25	2.64 (433)	0.61	2.60
Butachlor	0.75	EC+sand	185	2.00	2.57 (379)	0.49	1.94
Thiobencarb	0.75	EC+sand	93	1.25	2.57 (391)	0.50	2.97
Thiobencarb	0.75	Granules	148	1.25	2.62 (426)	0.48	2.45
Oxadiazon	0.50	EC+sand	107	1.25	2.66 (468)	0.46	2.50
Anilophos	0.50	EC+sand	105	1.25	2.58 (381)	0.41	2.24
Fusilade	0.20	EC+sand	464	2.50	2.50 (332)	0.49	1.42
Fusilade	0.24	EC+sand	532	2.50	2.38 (255)	0.40	1.31
Slow release—lac-2, 4-D (17.7% a i.)	0.40	WP+sand	393	2.00	2 49 (312)	0.71	1.70.
2, 4-D (98% a.i.)	0.40	WP+sand	292	2.00	0.33 (153)	0.33	1.05
2, 4-D (80% a i)	0.40	WP+sand	151	2.00	2.53 (351)	0.51	1.74
Oxyfluorfen	0.10	EC+sand	176	1.25	2.62 (440)	0 44	2.53
Pendimethalin	1.00	EC+sand	340	1.25	2.28 (193)	0.47	1.10
Hand-weeded check (two HW)	—	—	80	—	2.57 (393)	0.53	2.64
Unweeded check	—	—	357	—	2.40 (277)	0.44	1.48
LSD (0.05)			228	—	0.24	0.17	0.65

HW: Hand-weedings

(Figures in parentheses indicate original values), Phytotoxicity rating : 1 : No toxicity 5 : complete kill.

it is possible to adopt this system of rice culture for extensification of rice area in dry season.

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Variability in the morphine content of opium poppy latex and its unlanced capsules

The opium poppy (*Papaver somniferum* Linn.) is commercially cultivated for production of its alkaloids. The alkaloids are obtained from poppy plants in two ways : (a) From the latex of capsules called opium gum and (b) from the poppy-straw which means dried mature capsules along with stem. In India, latex is produced for the extraction of opium alkaloids. Its collection is highly skilled and labour-intensive process. However, in Europe and Australia, the poppy-straw is mainly used for the production of alkaloids due to constraints of labour and to reduce cost of production. Several European countries, import incised capsules from India to recover the balance quantity of opium which remains in lanced-capsules after incision. This means that a part of opium alkaloids is lost when collected through lancing. In view of these observations, the authors carried out studies to develop a suitable laboratory method for the extraction of morphine from the unlanced capsules. This is also expected to prevent possibilities of clandestine trade in opium gum in the country.

It is to reiterate that presence of bound form of alkaloids[1] in capsules, the process of extraction is rather complicated. In order to eliminate this difficulty, a method has been developed for releasing the alkaloids from bound form.

Ground poppy unlanced capsules (2 gm) was triturated with 20% saline solution and it was stirred for 1 hr. Now this was further treated with a solvent mixture of methanol and benzene (1 : 1) (25 ml). The mixture was shaken for ½ hr. Later on, this was filtered under suction. The filtrate was treated with 20 ml HCl (0.5 N) and kept in a separating funnel. The alkaloid comes into aqueous layer which is then separated. The pH of the aqueous layer was maintained between 4 to 6. Now 5 ml HCl (1.0 N) was added and it was made up to 100 ml. This solution was tested by TLC for the presence of major opium alkaloids (morphine, codeine, thebaine, papaverine and narcotine). Now, the morphine content was determined following the method of Pride and Eastern[2].

The data of morphine content in unlanced husk and opium latex is recorded in Table 1. Fiftytwo samples of opium latex and unlanced capsule of the varieties viz. NOP-1, NOP-4,

TABLE 1 : Yield and morphine content of opium latex and unlanced capsule in different varieties of opium poppy

Variety of opium poppy	Opium yield (kg/ha)	Unlanced capsule yield (q/ha)	Morphine (%) in opium latex	Morphine (%) in unlanced capsule	Morphine content in opium latex (kg/ha)	Morphine content in unlanced capsule (kg/ha)
NOP-1	17.91	4.76	12.35	0.66	2.210	3.14
NOP-4	20.10	5.30	13.31	0.63	2.665	3.47
U. O.-185	12.70	3.77	12.90	0.51	1.647	2.05
U. O.-285	10.00	4.34	12.89	0.58	1.287	2.52
MOP-409	10.20	3.48	12.25	0.51	1.250	1.77
MOP-503	11.66	3.55	13.84	0.51	1.560	1.81
MOP-78/16	11.45	4.92	13.48	0.55	1.885	2.00
FD Local	15.67	3.18	12.11	0.64	1.512	2.70
IC-19	11.09	4.17	13.97	0.63	1.535	2.66
IC-30	12.19	4.18	12.25	0.61	1.480	2.81
IC-42	12.45	4.03	11.95	0.51	1.490	2.08
IC-88	13.08	3.80	13.49	0.51	1.760	1.93
IC-128	11.30	3.57	11.75	0.50	1.340	1.79

U. P.-185, U. O.-285, MOP-409, MOP-503, MOP-78/16, FD Local, IC-19, IC-30, IC-42, IC-88 and IC-128 were collected from the experiment carried during the Rabi season of 1986-87. The morphine content in opium latex and unlanced capsule was estimated colourimetrically and solvent-extraction technique respectively. It was found that the morphine content in unlanced husk in all the varieties was more than the morphine content in opium latex.

The authors express their sincere thanks to Prof. and Head, Deptt. of Horticulture and Director Research, N. D. University of Agriculture & Technology, Narendra Nagar, Faizabad for providing the facilities.

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Received : 21 September, 1988.
Revised : 4 November, 1988.

---

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Two new seed-borne *Alternaria* spp. pathogenic to chilli crop in Kumaun Hills of U. P., India

Seeds, seedlings, infected leaves and fruits of *Capsicum annuum* L. and *C. frutescens* L. collected from 12 different agroclimatic conditions of Kumaun Himalaya were studied for the association of fungal flora, adopting the methods of International Seed Testing Association[2].

During this investigation, two new seed borne *Alternaria* spp. viz; *Alternaria brassicae* and *A. raphani* were detected from seeds, seedlings, leaves and fruits or both the chilli species and identified with the help of standard literature[3,4]. Both the species caused seed rot and pre- and post-emergence damping-off of seedlings in blotter and agar-plate method.

In leaves, *Alternaria brassicae* caused small, sunken, water soaked spots in concentric light and dark bands. The spots coalesced to form bigger ones. Under humid, warm weather, the whole leaf blighted and dropped-off. Infection of *A. brassicae* was recorded commonly mixed with *Cercospora capsici* and *Phoma destructive* (Plate 1A).

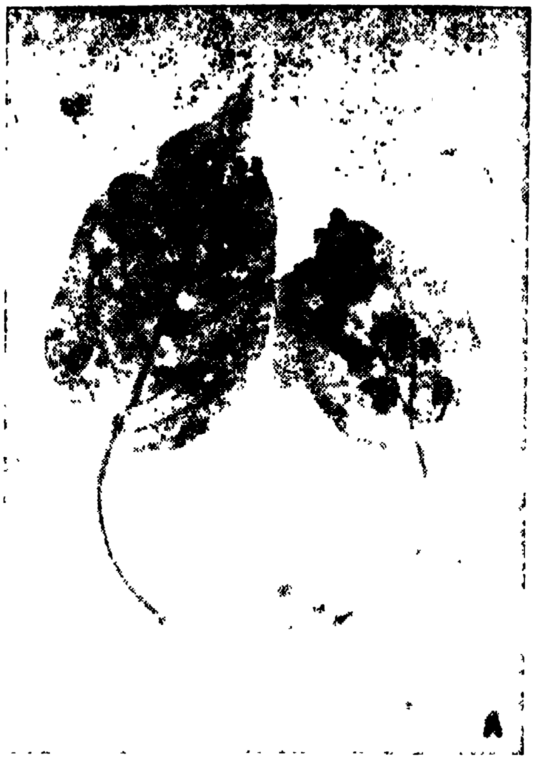
In fruits, a few black round to irregular, sunken spots with grey black mycelium developed near the tip.

A. raphani attacked mature leaves causing small, brown to black spots (up to 0.8 cm in diameter) in concentric rings throughout the leaves (Plate 1B). In fruits, it caused wrinkling and dark black discolouration. The taxonomic characteristics of the species are as follows :

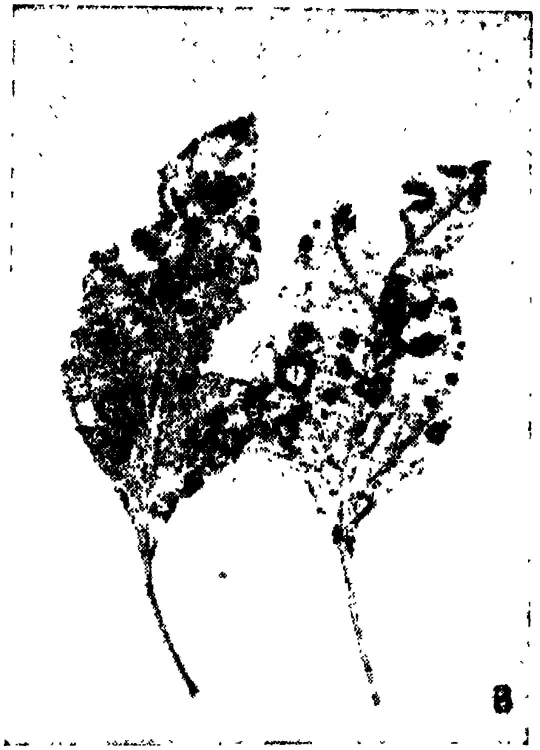
Alternaria brassicae : Colonies grey brown to black, amphigenous, hairy ; mycelium immersed, branched, septate ; conidiophores dark, arise in fascicles, geniculate up to 167 μm long, 5-10 μm thick ; conidia solitary, occasionally in chains, dark, obclavate, muriform, 71-200 μm long and 15-27 μm thick.

A. raphani : Colonies greenish brown to dark black, amphigenous, hairy, mycelium immersed, branched, septate ; conidiophores simple, occasionally branched up to 145 μm long, 3-6 μm thick, conidia are in short chains, obclavate, beaks short, smooth, olive brown, muriform 14-20 μm broad and 60-115 μm long. Chlamydospores formed abundantly in culture, some times in chains, first one celled and round finally becoming many called and irregular, olive brown.

PLATE-1



(A) Leaves of Bell pepper (cv. California wonder) showing mixed infection of *Alternaria brassicae*, *Cercospora capsici* and *Phoma destructiva*.



(B) Bell pepper (cv. Bullnose) leaves showing dark black necrotic lesions covering the large area of leaves by the infection of *Alternaria raphani*.

Pathogenicity tests of the pathogens against the host plant was made by infestation of healthy seeds with fungal inoculum and sown in pot soil under glass house conditions adopting the method of Suryanarayana and Bhombe[1]. Seed germination, seed and seedling infection resulting in seed, root and collar rot, and leaf blight were recorded.

Alternaria brassicae caused 25% seedling infection out of only 55% germinated seeds of ***Capsicum annuum*** and 21.5% seedling infection out of 60% germinated seeds of *C. frutescens*. ***Alternaria raphani*** caused 22.22% and 24% seedling infection out of 54% and 50% germinated seeds of ***Capsicum annuum*** and *C.* ***frutescens*** respectively. However, in control 89% seed germination was recorded without any seed and seedling infection in both ***Capsicum annuum*** and *C.* ***frutescens*** respectively.

Infected seedlings showed wilting and curling with small, brown and slightly necrotic spots in young leaves. Inside the soil, several seeds were found heavily rotted by the fungal mycelium, which showed a large number of chlamydospores and conidia. Seedling infection was rapid from 10th to 18th day of seed sowing. These results clearly indicate the destructive nature of these pathogens.

The authors are grateful to I. C. A. R., New Delhi for providing financial assistance.

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Received : 17 February, 1988.
Revised : 9 March, 1989.

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Nutritive value of the *Sterculia foetida* nuts

Sterculia foetida L., a hardy and robust tree of the tropical and subtropical regions of the world, is now-a-days planted along the avenues in many parts of India including West Bengal. The tree grows abundantly in the Chhotanagpur plateaue of Bihar, West Bengal and Orissa and attains a height of up to 30 m. Besides the arboricultural and silvicultural importance, the tree also produces edible nuts of good taste, encased in hard reniform jackets which assume attractive red colour on ripening. Under local conditions, each tree has been found to produce up to 500 fruits (follicle) and up to a maximum of 14 nuts were observed to have matured in a single fruit.

In the present study, the fruits which just ruptured along the suture, indicating their full maturity, were harvested in the month of February 1988, from three trees growing in South Calcutta. The nuts on removal were made into random samples for the determination of their weight, size and specific gravity (by water-displacement method) of the intact nuts as well as total protein and the total ether-extractable lipid content of the peeled kernels. The total protein content of the representative samples of the fresh kernel was estimated by the method described by Lowry *et al.*[1] In determining the ether-extractable lipid content, a known quantity of fresh sample was extracted in di ethyl ether at room temperature and filtered. The filtrates were taken in previously-weighed glass dishes and slowly evaporated to dryness in a water-bath (60-65°C), after which the dishes containing the residues were weighed to determine the lipid content on weight-basis over fresh samples. All the tests were repeated 8 times and the average results given in Table 1.

TABLE 1 : Qualitative characteristics of nuts and kernels

Length of nut (cm)	Thickness of nut (cm)	Sp gr of nut	Wt/nut (g)	Thickness of peel (cm)	Kernel : Peel ratio wt basis	Total protein of kernel (%)	Total ether-extractable lipid content of kernel (%)
2.8	1.1	1.06	1.93	0.002	1.1	16	37
S.E. 0.014	0.007	0.003	0.003	0.00007	0.005	0.12	0.47

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Received : 4 November, 1988.
Revised : 1 February, 1988.

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(i) R. B Walton and H. B. Woodruff, *F. Clin. Inst.*, **82**, 924, 1949.

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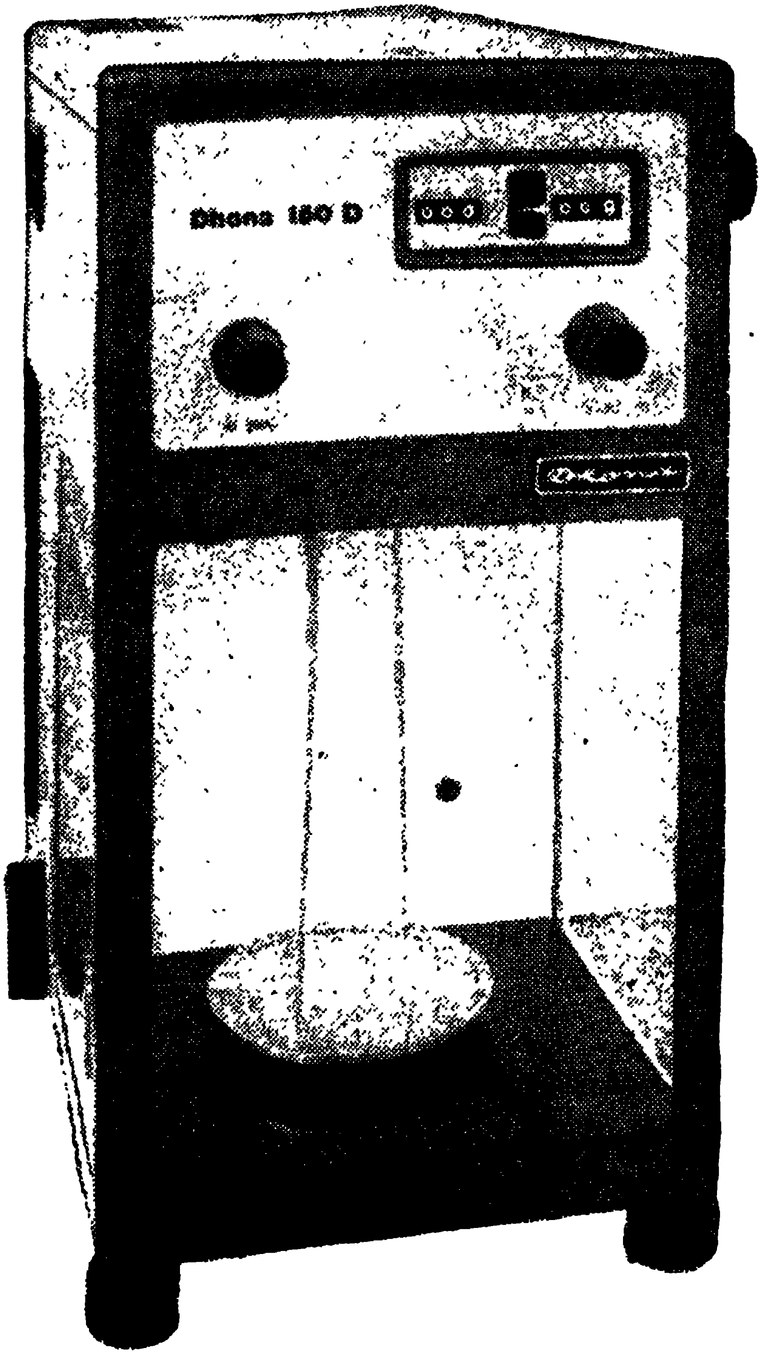

Published and Printed by Santimay Chatterjee, on behalf of the Indian Science News Association,
92, Acharya P. C. Road, Calcutta-700 009 at B. G. ART PRINTERS ★ CALCUTTA-700 054.

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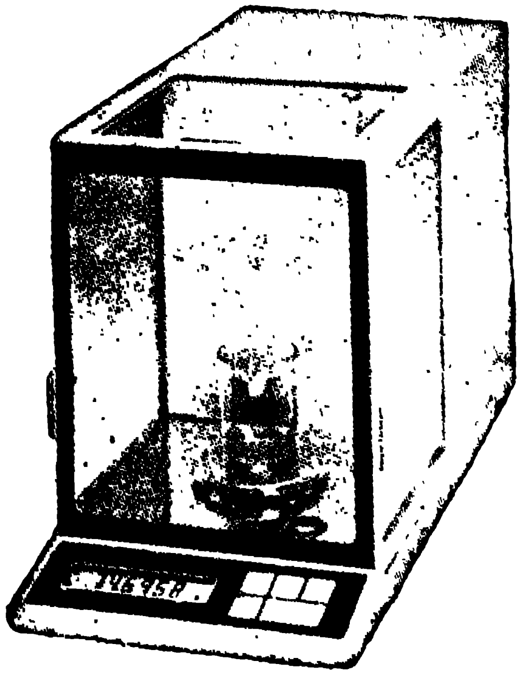

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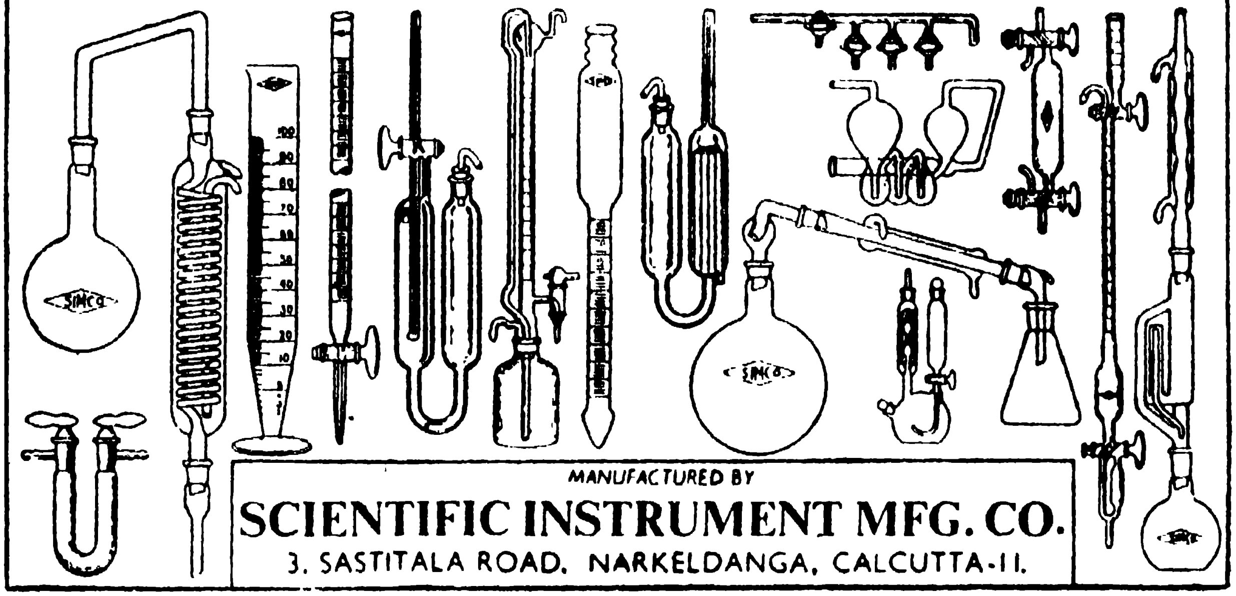

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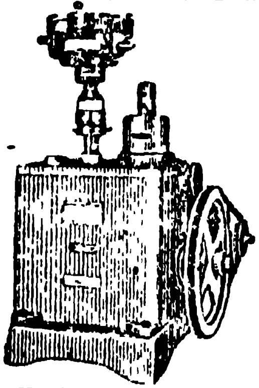

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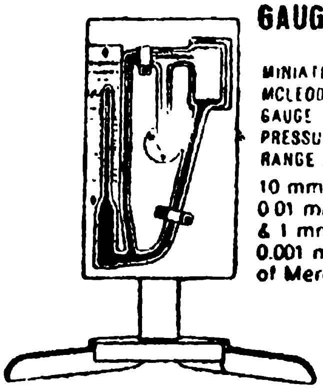

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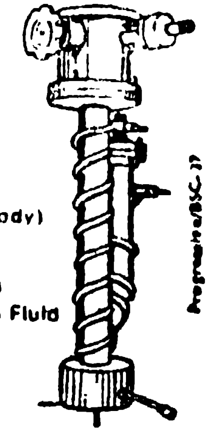

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A MONTHLY JOURNAL OF NATURAL & CULTURAL SCIENCES

July 1989 / Volume 55 / Number 7

PUBLISHED BY THE

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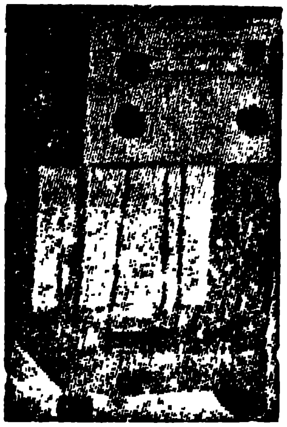

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HOT AND COLD

THERE is always some excitement in the world of physics. This time it is the cold fusion. It is well established that the nuclear fusion of hydrogen and its isotopes forms the principal source of energy in the stellar bodies. But this can happen only at very high temperatures of the order of 100 million degrees. That is how the hydrogen bomb operates. A fission bomb produces the temperature high enough in which deuterium or tritium fuses producing the vast energy of the megaton bombs. Cold fusion as reported now is possible at room temperature. Stanley Pons and Martin Fleischmann announced at a now famous press conference on 23rd March, 1989 at the University of Utah that they have observed fusion of deuterium at room temperature with release of neutrons and some amount of heat. This has been accomplished in an apparently simple electrolysis experiment. In a common class room experiment if a small current is passed between two electrodes immersed in slightly acidic water contained in a cell electrolysis takes place. The positive hydrogen ions go towards the negative electrodes and the negative oxygen ions go to the positive electrode. The gases bubble at the two electrodes and can be collected with suitable arrangement. If ordinary water (H_2O) is replaced by heavy water (D_2O) and the negative electrode is made of palladium, the whole situation changes. Palladium is known to absorb a large quantity of hydrogen. During electrolysis the deutorium ions (D_2) which arrive at the palladium electrode is absorbed within the metal. In course of time the palladium electrode is packed with large number of deutrons to the extent that the deutrons are so close as to fuse liberating neutrons and heat. When two neutrons fuse they produce ^{3}He (0.82 MeV) and n (2.45 MeV) or tritium-^{3}H (1.01 MeV) and proton p (3.02 MeV). The Utah scientists claimed that they detected the production of neutrons tritium and helium—the expected by-products of fusion reactions—in addition to heat. They also claimed that the experiment produced four watts of power for each watt of input. This became a very hot news because scientists have been trying very hard to master the fusion energy which is the only alternative source that the human race has to fall back upon. On the basis of the Utah experiment the scientists calculate that the energy released by the D pairs contained in one gram of deuterium will be as much as that by 9,500 liters of gasoline. Not a bad prospect indeed.

The experiment described looks too simple. But in reality it is not so. The electrolyte is a mixture of D_2 and a number of various salts. Their proportions have to be perfected by experimentation. Deuterium is not such an easily accessible material particularly in India where the Atomic Energy Department has the monopoly. Again palladium is a very tricky metal, the metallurgy being quite complicated. The neutrons that come out are so few in number that to detect such small number of neutrons against the background of other radiations would need very sophisticated instrumentation. However, since the announcement of the news many laboratories in the world are trying to repeat the experiment. Such attempts have also been made in India. The announcements are all through newspapers and T. V. discussions so it is very difficult to judge whether the fusion occurs at all and if the heat released can ever be used for commercial purposes. A number of positive and negative results have come out. A group of scientists from Grigham Young University, Provo, Utah and University of Arizona, Tuscon, Arizona have in *Nature* (27 April, 1989) reported a positive result detecting neutrons in the 2.5 MeV range which are 1.5 to 3.5 times the background radiation. They estimated from the neutron production rate 10^{-23} fusions per deutron pair per second. But they do not mention any release of heat. The same issue of *Nature* reports that Dr. David Williams, leader of a large team of scientists of the UK Atomic Authorities of Harwell who had been investigating cold fusion since February has finally given up, because the laboratory could not devote the man-hours, money and material needed for the project. The ten scientists led by Williams had spent three months and £ 320,000 on these studies. Dr. Williams feels 'that the Harwell experiments have covered every conceivable aspect of palladium metallurgy, a murky subject which has frequently been invoked as an explanation for the purported success of a few experiments amidst the failure of the most. But the Harwell team has not been allowed access to any of the palladium electrodes from Pons and Fleischmann's working cells, which are now back with Johnson Matthey'.

There is another interesting aspect of the cold fusion phenomenon. The tritium (^3H) released in the process decays into ^3He with a half-life of 14.2-Yr. It is well established that solids, liquids, and gases associated with volcanoes and hot sprigs have a high $^3He/^4He$ ratio. In fact such excess of ^3He in helium gases coming out of Bakreswar and Tantloi hot springs were reported by Shyamadas Chatterjee and Debasish Ghosh many years ago. Is it possible that cold fusion is going in the interior of the earth's crust which produces the excess ^3He observed ? Jupiter radiates twice as much energy as it receives from the sun. Is it possible that cold nuclear fusion in the core of Jupiter is providing the excess heat ? There are many such possibilities.

In spite of the discouraging remarks of Dr. Williams, the hunt is on. Many institutions in India including BARC and TIFR at Bombay are at it. Bikas Sinha and a group of scientists at VECC and Prasanta Sen of SINP have observed "Bursts of neutrons in the electrolysis of heavy water". Lali Chatterjee of Jadavpur University wonders—could these fusions be triggered by cosmic ray muons—because calculations match the number.

From time to time such hot topics come up—the magnetic monopoles, solar neutrinos, five-fold symmetry of quasicrystals, the fifth force of nature are still keeping scientists busy. Conferences are held at regular intervals to assess the progress. In the Moriond workshop 'Tests of Fundamental Laws of Physics 'held recently in Les Arcs, in the French Alps new experiments looking for non-Newtonian gravity were discussed, where emphatic no's and not-so-emphatic yes's were reported leading to no conclusions.

Scientists never give up, no matter how formidable and expensive the projects are. The Institute of Nuclear Physics in Rome is setting up a very elaborate facility at Gran Sasso about 50 km from Rome below a mountain. There is a highway through the mountain. The scientists have used this tunnel way for access to their underground experimental station—three excavated halls 100 m × 20 m × 18 m. A 60,000 litre gallium tank will look for solar neutrinoes and a 72 m 'catch all' detector is being set up for studying the monopoles, astrophysics and rare cosmic ray events.

How long does a topic remain hot ? The CP mystry is now 25 years old, yet new experiments are being planned. 25 years is not a very long time in the history of human knowledge. The cold fusion phenomenon has just started. Scientists all over the world are keenly watching the developments. ☐

Santimay Chatterjee

BIOTECHNOLOGY IN THE OILS AND FATS INDUSTRY*

M. M. CHAKRABARTY**

A simple and useful definition of biotechnology is the manipulation of living organisms and/or biological processes to provide useful products. This science has a long past and a fascinating future. Man has been exploiting biotechnology for thousands of years to make bread, to grow alcohol, to produce cheese and for a shorter period to treat sewage. In recent years, scientists have developed a deeper understanding of the control mechanisms by which living organisms produce specific chemical materials and are learning to adapt this knowledge for the benefit of the human race. The impact of biotechnology is different for the developed and developing world. Confining our review to the developed world it seems that we can produce more food than we need and research is on for crops which will either produce new or modified dietary products or provide better raw materials for the Chemical Industry that are now available from low yielding materials or food surpluses. In the so-called developing or undeveloped world the situation is exactly opposite. There the need is for producing useful materials by the use of living cells or their components for (1) improvement of oil producing plants, both annual or perennial, to give yield and uniformity ; (2) to use the biological processes by using yeasts, molds, algae and some bacteria to produce oils and fats what are popularly known as single cell oils which are potential raw materials for oils and fats industry. The micro-organisms are grown in fermentors in a carbohydrate carbon source. Many micro-organisms can produce large amount of inter-cellular lipids with unusual compositions. Further the use of Recombinant DNA Techniques is increasing the range of lipids produced by micro-organisms. Biotechnology has also been used in processing of oils and fats to manipulate the composition of triacyl glycerol mixtures for food use and to prepare a wide range of fatty acid derivatives used in many commercial products and processes. There is increasing interest in the exploitation of biocatalysis for the modification of fatty acids and their derivatives either to replace the existing methods with milder and more natural and perhaps the cheaper techniques to provide novel products or more easily produced than by chemical processes.

The potential or current biological methods which have impact on oil and fat industry. These are, viz :

(1) The domestication of wild plants to produce new lipid materials ;

(2) The improvement and modification of existing crops by plant breeding, cloning and genetic manipulation ;

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[*] 4th Santanu Ghosh Memorial Lecture delivered on January 27, 1989 under the auspices of the Indian Science News Association.

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(3) The production of edible oils from micro-organisms ;
(4) The use of enzymes in the processing and modification of oils and fats ;
(5) The use of enzymes in the structural modification of fatty acids.

Further possibilities are :

(1) Use of biotechnology in chemical plant growth regulators ;
(2) Crops agriculture and agro-chemical industries ;
(3) Surfactant production ;
(4) Control of reproduction, lactation and growth in farm animals ;
(5) Manufacture of speciality and commodity chemicals ;
(6) Microbiological pest control agents ;
(7) Biopolymers ;
(8) Biocatalysts ;
(9) Biofuels ;
(10) Biotransformation reactions ;
(11) Membrane separation processes ;
(12) Food processing ;
(13) Post-harvest biotechnology in agriculture ;
(14) Industrial Biocides and
(15) Natural chemicals.

This list is not exhaustive but indicative on the scope of biotechnology and an attempt has been made here to list those which have some impact on oils and fats.

Application of Lipases :

These enzymes are secreted by micro-organisms into their growth medium to modify lipids and they can be produced cheaply on large scale from several microbial species by fermenting. Lipase catalysts are used for hydrolysis of fats and oils to give fatty acids, diacyl glycerol, mono-acyl glycerol and glycerol. Reaction is reversible and the enzyme has been shown to catalyse the formation of acyl glycerol from glycerol and fatty acid. The natural substrates for lipases are acyl glycerol but they also catalyse the hydrolysis of many other types of fatty acid esters. The enzyme can have specificity with respect to either the fatty acyl or alcohol part of the substrates and the substrate specificity of the lipases is crucial to their application in industrial processes.

Fat Splitting :

The commercial availability of comparatively cheap microbial lipases has caused an increasing interest in their use for fat splitting. Lipases showing no regio-specificity are particularly suitable because they catalyse to almost complete hydrolysis of fats to fatty acids and glycerol. For example, *Candida rugosa* lipase can be used to give 95 to 98% hydrolysis of various oils. The usual procedure for enzyme catalysed fat splitting is to mix the lipase in buffer with melted fat in a stirred tank reactor for several hours. At the end of reaction period the fatty and aqueous phases are separated and processed for fatty acid and glycerol recovery. Alternative continuous processes using counter-current flow of fat through lipase or hydrophobic membrane systems have also been described. For high melting fats which require highest reaction temperatures, suitable thermostable lipases are to be developed although at the present moment enzymatic methods have to be more costly than the conventional chemical methods. There have been recent reports in Japan about the use of *Candida rugosa* lipase for splitting of tallow to produce better quality fatty acid and glycerol. Moreover, they are also favoured for preparation of polyunsaturated fatty acids from fish oil and hydroxy fatty acid from castor oil. Again, partial splitting of oils and fats using fatty acid specificity is used to produce fractions enriched with particular types of fatty acids. For example, the extra cellular lipase produced by mold *Geotrichum candidum* specifically releases from oils and fats fatty acids with a *cis* double bond in the 9 position. A method has been proposed to use the enzyme to obtain pure oleic acid from partially hydrogenated fat containing oleate and its isomers. The discovery of microbial lipases with other types of fatty acids specificity could result in the development of new processes for the production of high value fatty acid materials.

Interesterification :

Because of the reversibility of the lipase catalysed reaction, hydrolysis and resynthesis of triacyl glycerol occur when lipases are reacted with oils and fats. This causes an interchange of fatty acyl groups between triacyl glycerol molecules and gives interesterified products. Under conditions in which the amount of water addition is restricted, hydrolysis of fat can be minimised so that interesterification becomes the dominant reaction. Mixture of triacyl glycerol in fatty acids can be used as reactant for interesterification and in these cases free fatty acids exchange with the fatty acyl groups of the triacyl glycerol to produce new triacyl glycerol enriched in the added fatty acid. Various types of products can be produced by (a) a non-specific lipases ; (b) a regio-specific lipases. So, by manipulating the reactants in reaction condition value added products have been prepared. At present the main application of lipase catalysed interesterification is production of high value confectionery fats but in the long term it may be possible to use the technique to manufacture triacyl glycerol mixtures with useful functional properties in products such as margarine, bakery products and low calorie spreads. However, much more developmental efforts are necessary.

Estersynthesis :

The ability of microbial lipases to remain catalytically active under conditions of very low water availability can be used to produce a wide range of fatty acid esters either by esterification or by alcoholysis reaction. In the case of esterification high yields can be obtained by removing water as it is formed. By exploiting the specificity of lipases and mild reaction conditions it may be possible to produce esters which are difficult to obtain by chemical methods. This also need further development although the indications are there.

Modification of fatty acids :

The following reactions have been shown to be performed by microbial enzymes ; viz.

(1) Hydratase from a Pseudomonas and other bacteria which can catalyse the hydration of oleic acids to 10-hydroxy stearic acid.

(2) An isomer from the same Pseudomonas can convert oleic acid to its trans 10-isomer which is bioelaidinization.

(3) A conjugase present in rumen bacteria can convert linoleic acid to *cis* 9, *trans* 11 octadeca dienoic acid. These types of reactions potentially are amenable to commercial exploitation with existing enzyme technology using immobilised isolated isomers or non-viable cells. The main technical problems are mass transfer and catalyst stability.

The Chemical engineering problems to ensure the reactions to take place efficiently are under development and also partially developed.

Oxidative Reaction :

Fatty acids and their esters are subjected to wide ranges of potentially useful oxidative reaction in the cells of micro-organism. Some examples are : (1) desaturation of stearic acid to oleic acid, linoleic acid and linolenic acid catalysed by a series of positionally specific desaturated enzyme complexes ; (2) the conversion of unsaturated fatty acid to epoxy fatty acid and (3) oxidation of fatty acid to give dicarboxylic acid.

These oxidative reactions are catalysed by enzyme complexes which are generally unstable and difficult to isolate and they require—in addition to oxygen—the expensive Pyridine Nucleotide Confactors NADPH. These confactors are under development through electochemical and enzymetic methods. Further examples of bioconversion processes is introduction of functional group in polyunsaturated fatty acid by an oxidative reaction has been possible by the use of the enzyme lipoxygenese found in soyabean meal and it has been suggested that linoleic acid can be converted to hydroperoxy conjugated octadeca dienoic acid. These lipoxygenese does not require the confactors mentioned above.

Biohydrogenation :

Suggestions have been made that it may be possible to develop the biohydrogenation processes in a reaction sequence using the enzymes conjugates and reductase. However, this is yet to be developed.

What has been stated in the foregoing are but some indications of the possibilities of biotechnology in oils and fats but as has been mentioned earlier the whole gamut of reactions possible for oil production, genetic manipulation of oil crops, hybridization and genetic engineering are being developed for being exploited but as of now only the door has been opened and at this moment it seems there is no limit. ☐

BIOTECHNOLOGY : A GLOBAL HOPE

J. S. YADAV, SUNITA GROVER AND V. K. BATISH*

MAN in the past has been benefitted by the fruits of science and technology in a spectacular way. However, the priorities for various technologies have been changing with the changes in the needs and aspirations of mankind. Currently, a new technology, called Biotechnology, is receiving the topmost priority all over the world and is aiming at revolutionizing different walks of life namely medicine, industry, agriculture, animal husbandry, environment etc. Biotechnology has, therefore been rightly called a 'biorevolution'.

What is biotechnology ?

The term biotechnology has been defined in a number of ways as follows :

"The application of biological organisms, systems or processes to manufacturing industry".

"The technological exploitation and control of biological systems".

"The exploitation of micro-organisms or their components to provide certain goods or services".

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"The application of the chemical processes encountered in biological cells for industrial purposes".

"The scientific activity concerning the integrated application of biochemistry, microbiology and process technology on biological systems on behalf of industrial processes and environmental management".

However, a broader and most widely accepted definition says that biotechnology is "the application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services". The term biological agents encompasses enzymes, micro-organisms (unicellular or multicellular), plants and animals.

Although some of the processes included under biotechnology have been conventionally practised (called "old biotechnology"), but the modern hue and cry of biotechnology is due to the endless possibilities of modifying the biological agents through genetic engineering/recombinant DNA technique to suit to the needs of mankind. It is this branch of biotechnology (called "new biotechnology") that has attracted the worldwide attention and has given a new turn to the whole scenario of global research. Nowadays, the solution to any problem is sought through this novel tool of biotechnology. Apart from recombinant DNA techniques, new tools like immobilization of cells, protoplasts, enzymes and cell fusion (hybridoma technology) hold a great promise under biotechnology. The advances bioprocess technology is another area that plays a vital role in the new biotechnology.

Global need for biorevolution

In view of the wide scope of new biotechnology, the modern world has laid its future hopes on this technology for subsistance and all round progress and development. Before discussing the gains and aims (targets) of biotechnology, an insight into the global problems of mankind would emphasize the necessity and scope of 'biorevolution'. In the Global 2000 report, a three year study commissioned by the United States Council on Environment Quality and the State Department, the projections made for different areas for the year 2000 are as follows : (i) the population in the world would reach around 6.35 billion in 2000 as against only 4 billion in 1975. In less developed countries along, 90% part of the population growth will take place, thereby, leading to larger existing gap between the rich and poor countries. (ii) the per capita food consumption in the less developed nations will scarcely improve and may even decline in some cases in 2000 A. D., though the food production may increase. This will lead to doubling of the real price of food, (iii) the problem of water shortage will aggravate mainly at places of existing shortage, (iv) the arable land will increase by only 4% meaning thereby that the increase in food production would result mainly due to improved agricultural technology, (v) the agricultural soil will deteriorate widely due to increase in soil erosion, desertification, organic matter loss, alkalinity, salinity, water logging, etc., (vi) the continuous exploitation of existing energy (fuel) resources like oil, gas, coal, etc. will reduce the reserves though they will not be exhausted completely. Efforts to maintain the reserves of non-fuel minerals will need to be intensified. The need for fuelwood will exceed the availability by about 25% by 2000 AD. Apart from these problems, mankind is facing new damages to human health through microbial and non-microbial diseases (some of which are incurable like cancer, AIDS), environmental pollution etc.

Potentials and Progress

So far biotechnological techniques have been exploited in different countries to variable magnitude. Japan and four European countries namely, the Federal Republic of Germany, the United Kingdom, Switzerland and France, are believed to be the major competitors of USA in the commercialization of biotechnology. These countries have identified this new technology as a potent area for economic growth. In France, biotechnology has been estimated to generate 30,000 new jobs and 6,000 research positions during the eighties. Japan is earning nearly 5 per cent of its Gross National Product through biotechnology. The enormous potential of biotechnology has caused the diverting of a gigantic portion of annual world expenditure to R & D in this field. Among European countries, West Germany spent about 10 times that of France and U. K., nearly 100 million dollars during 1972-78. In the United States, private sector investments to commercialize the new techniques of biotechnology exceeded 1 billion dollars in 1983. In the race of this novel technology, India has also not lagged behind, where a separate department of biotechnology has been established to co-ordinate and finance the biotechnological activities. Biotechnology can have tremendous impact on developing countries including India where the living standard of the people could be greatly improved by exploiting the biotechnology potentials in their priority areas like agriculture, animal husbandry, medicine etc. Realising the importance of biotechnology to developing countries, United Nations Industrial Development Organisation (UNIDO) has rightly set up an International Centre for Biotechnology located at New Delhi (India) with an annual budget of 8.6 million dollars. This centre, would concentrate exclusively on problems specific to developing countries.

The new technology aims at meeting the future needs of mankind in the areas of pharmaceuticals, foods and feeds, fertilizer, energy, environment etc. In the last decade, new techniques have been developed to modify microbes, plants and animals to increase their usefulness in attaining these objectives. Efforts are concentrated on cloning the genes of the proteins which are produced in eukaryotes in small amounts but are necessary for the society in larger amounts. The possible role and the progress made so far in various beneficiary areas by the biotechnology are described in the following pages.

Human Health :

Different pharmaceuticals like interferon, insulin and other harmones, antibiotics, monoclonal antibodies, human virokinase etc. have either been produced by recombinant DNA techniques or their yield has been increased manifold. This aims to reduce the cost and ease of production in required quantities.

Production of interferon (a wonder protein drug for cancer and viral diseases) and human insulin (a harmone required to rectify diabetes) has been revolutionized through biotechnological applications. According to available estimates, by 2000 A. D. it would be possible through biotechnology to produce interferon, insulin and vaccines worth 2000, 235 and 260 million US dollars. Human insulin has been the first recombinant DNA pharmaceutical product approved for use in the USA and the UK in 1982. Besides, we may imagine the insertion of insulin gene in the diabetic person itself so as to alleviate the injection of insulin. The other possibilities could be the implantation of insulin producing microbes in the human body coupled with an autocontrol for insulin levels. A harmone, somatostatin, 5 mg of which was produced from half a million sheep brains can now be produced from a 9 litre bacterial culture.

Genetherapy and development of multi-disease vaccines are the other areas where bio-technology is expected to yield wonders. It might be possible to rectify the hereditary diseases through genetherapy. The recent achievement in laboratory animals, i.e. producing large size mice by transfer of growth harmone gene, the possibilities of eugenics (creating desired humans) seem bright. What is considered an imagination today might turn out to be reality in not too distant future.

Food Problem :

Man derives food mainly from plant and animal resources. Biotechnology holds a tremendous potential in improving these resources in various ways.

Improvement of crop plants through genetic manipulation would go a long way in meeting the escalating necessities of food. Some useful traits like herbicide-, drought-, frost- and pest-resistances might be transferred to important crop species in coming years. Progress has already been made in transferring the frost resistance genes into crop plants. Work is being done on increasing growth rate, photosynthetic ability and nitrogen fixation in plants —through genetic tools of biotechnology. Micro-organisms interacting with crop plants offer further possibilities for improvement through such techniques. The modification of nitrogen fixing microbes, which act as biofertilizers, is in progress and it is hoped that substitution of chemical—with bio-fertilizers would be possible in future. This raises new hopes for boosting and economising the food production through biotechnology.

Animals which provide meat, milk and other food items or other necessities can be improved genetically for these traits. The yield of these products may be improved through better health-care of the animals by biotechnologically produced pharmaceuticals. The most important animal pharmaceuticals are likely to vaccines and growth promotants. The first recombinant DNA animal vaccine (for colibacillosis) was approved for use in Europe in 1982. Recently, a protein that increases milk production in dairy cows and improves feed utilization has been produced with the help of genetic engineering techniques in USA. This protein is expected to be commercialized in a couple of years to increase the economy and efficiency of dairy farming all over the world. Many more such products are likely to enter market in near future. Embryo transfer technology which has been commercialized in some countries like Australia will enhance animal production in a big way in the years to come. Biotechnology would also boost animal productivity by providing improved and new feeds and fodders. For instance, the low quality roughages, could be improved through bioconversion processes and more suitable and convenient new varieties of fodder crops can be evolved through tissue culture and other genetic techniques.

A number of non-conventional food constituents like single cell protein, sweeteners, edible oils etc. and food additives like vitamins, amino acids etc. have been and can be generated through biotechnological processes. However, strict safety monitoring of such products needs to be carried out before releasing them for human consumption.

Biotechnology can also have a major role to play in better processing of food.

Bioenergy :

The existing petrochemical and other sources of energy are depleting fast with the advancement of modern world. One of the answers to the growing energy needs seems to be generation of energy through biotechnology. Processes have been developed for generating liquid and gaseous biofuels in recent years. Ethanol among liquid- and methane (biogas) among gaseous-biofuels constitute important alternatives to coal, wood, oil, petroleum and other existing sources of energy. Genetic manipulation of micro-organisms producing these biofuels can enhance their yield manifold and work is in progress on these lines all over the world. Various waste materials are being used for bioconverting them to biofuels by such micro-organisms. The other sources of bioenergy could be the hydrocarbon producing plants obtained through biotechnology.

Pollution Control :

The variety of toxic and non-toxic wastes (solid/liquid/gaseous) expelled everyday by industries are posing a serious threat to human life through environmental pollution. One of the potent methods of eliminating these wastes is through biodegradation. Certain micro-organisms have been known to do the job but not so efficiently. Genetic modification of such organisms and creation of new strains through biotechnological techniques hold a great promise in this area. A superbug, *Pseudomonas putida*, created by an Indian Scientist in USA, Dr. A. Chakravarty, through such techniques, can scavenge oil in sea. Many other such organisms could be created to degrade and detoxify a variety of harmful chemicals in the environment. This would avoid the possible ill effects on human health and such animal and plant species as are useful to mankind.

Bioelectronics :

Electronics is another area which is likely to be greatly benefitted through development of biosensors and biochips. Sensors using enzymes for detection of specific substances are now available but their applicability is poor due to their substrate specificity and temperature instability. More versatile sensors utilizing enzymes and monoclonal antibodies could be developed.

Biochips for use in electronic devices like computers can substitute the existing counterparts in future. However biochips appears to be one of the most distant applications of biotechnology.

A myriad other applications of biotechnology in areas like biometallurgy, space, communication, etc. could also be anticipated.

Based on our current scientific knowledge in various biotechnology disciplines namely molecular biology, genetics and fermentations, this new technology is considered a safe proposition. However, since biotechnology involves the manipulation of biological agents themselves, the possibility of long-term potential dangers cannot be overlooked. In view of this, it is imperative that before releasing any biotechnological product, a rigid testing should be prefixed to avoid possible complications to human life. Federal regulations in this direction will speed up product commercialization in the promising new field and significantly improve the competitive position of biotechnology firms engaged in the production of bio-products in the world market. However, the affluent tendency of pushing the newly introduced product, yet in the experimental stage, to developing areas needs to be discouraged globally. Above all, the possibility of deliberate or indeliberate creation of a potentially harmful microbe through recombinant DNA cannot be ruled out. If such outcomes fall in the hands of non-technical power-hungry politicians, the world may not live in peace and the dangers of biological warfare become imminent thereby setting to naught the myriad hopes from this promising technology for mankind. Hence, a judicious pursual and development of this technology is called for. □

TWENTY-FIVE YEARS OF INDIAN PHOTOBIOLOGY SOCIETY

K. K. ROHATGI-MUKHERJEE*

IT was early 1963 that Dr. E. J. Bowen of Oxford University wrote to me if I could organise a group in India actively interested in photo-chemistry and photobiology. The request had come from Dr. Edna M. F. Roe of Chester Beatty Cancer Research Centre, London who was then the Secretary-General of the International body the Comite´ Internationale´ de Photobiologie (CIP) which later changed its name to Association International de Photobiology (AIP). As Secretary General, she was actively interested in promoting international co-operation in many diverse fields of photobiology, comprising physics, chemistry and biology of photon induced phenomena, fundamental and applied. In the first committee to co-ordinate international organisation set up in Lausanne in 1928, people from medical profession were more active. But the need for collaboration with physicist, chemists and biologists became apparent to understand the basic mechanism of many diseases and also cure for many others, using natural sunlight and artificial light sources. Advances in the fields of molecular biology, vision, photosynthesis and photoperiodic responses in animal and plants, supported by advances in basic photochemistry, widened the concept of multidisciplinary approach to biological phenomena stimulated by light.

An active supporter of such activities in India was found in Late Dr. B. Mukerji who was then the Director of Chittaranjan National Cancer Research Centre. Dr. Mukerji had made outstanding contributions in basic and clinical work in the field of leucoderma and melanin pigmentation. He offered constructive advice and all the facilities of his office to start a small group in Calcutta. Late Professor S. M. Sircar, the then Head of the Department of Botany, Calcutta University and Professor N. N. Das Gupta, then Professor of Biophysics at the Saha Institute of Nuclear Physics also extended their full support. The nucleus of the Society, christened as Indian Photobiology Group, was finally established in February 1964 at the auditorium of CNCRC. The composition of the first Executive Committee was : President—Dr. B. Mukerji ; Vice-Presidents – Dr. N. N. Das Gupta and Dr. Sachindra Nath Mukherjee ; Treasurer—Shri Kanailal Bhattacharya ; Members—Dr. P. De, Dr. Sukumar Aditya, Dr. B. B. Biswas, Dr. B. Roy ; Secretary—Dr. K. K. Rohatgi. The fourth International Congress on Photobiology followed soon in Oxford, U. K. at which the affiliation of the Group with the International body was finalised. The Secretary attended the meeting as National Representative. Many of the founder members are present in today's gathering to herald the completion of twenty-five years of existence of the society. We are happy to have Dr. N. N. Das Gupta with us. Inspite of his age and failing health, he has agreed to attend the inauguration of the Silver Jubilee Celebration today. We had many scintillating and inspiring meetings in his room at the Physics Department of Calcutta University. We miss today the guiding spirit of Dr. B. Mukerji, Dr. S. M. Sircar and Dr. S. N. Mukherjee who are not with us. Dr. Aditya and Dr. Biswas are still an integral part of the society, serving the society in various capacities.

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A Bulletin of the Indian Photobiology Group was started in the same year to disseminate the philosophy of such an interdisciplinary group. Information gleaned from the Bulletin No. 2, August 1965 it is observed that the first Annual General meeting was held on December 31, 1964 in Applied Chemistry Lecture Hall of Calcutta University. The meeting was due to be inaugurated by Col. Sir Ramnath Chopra but due to indisposition he could not come. His inaugural speech was read by Dr. J. C. Ray, Ex-Director of Indian Institute of Biochemistry and Experimental Medicine, who presided over the meeting. Quoting from the inaugural speech of Col. Chopra I read : "I am happy to be with you this afternoon to associate myself with the worthy effort that you are making towards the organisation of an Indian Photobiology Group on the lines of international body. In these days of intense specialisation in every branch of natural sciences and medicine, we are tending more and more to work in closed watertight compartments, on details of methodology and techniques pertaining to each specific scientific discipline. This is probably necessary in the interest of new knowledge and new discoveries that are being made so quickly these days. However, interesting and exciting areas of research in the borderline field of sciences such as photobiology are assuming importance everyday. It is necessary here to make coordinated efforts of more than one group of scientists who should be able to join hands and brains to arrive at satisfactory solutions of multifaced interdisciplinary programmes and projects. The Indian Photobiology Group, I am glad to notice is keen on creating such a platform where medical scientists, botanists, agriculturists, physicists etc. can get together and study the direct applications of light and radiant energy on life processes in biological systems. Photobiology has a wide scope. In addition to its fundamental importance, it has ramifications in the study of photosynthesis, light absorption and energy transfer, photoperiodism, effects of radiation on nucleic acids and proteins etc. Medical aspects include vision and the effect of light on the skin and pigmentation processes. Agricultural aspects embrace the study of solar energy and of the uses of light sources in green houses and in poultry industry.........Atomic energy has its hazards—radioactivity, and sunshine has its hazard—sunburn and cancer. The group of photobiologists here, I feel sure, will be able to push back the frontiers of fundamental sciences in the areas where photochemistry and physiology meet".

The Inauguration was followed by a lecture by the President Dr. B. Mukherji on the nature of electromagnetic radiation. Professor Nil Ratan Dhar gave a talk entitled Light in Land fertility. Dr. Gobind Basu presented his lecture on "Energy transfer Phenomena in Biological Systems." At this meeting Dr. B. B. Roy, Vice-Principal and Professor and Head of the Dept. of Pharmacology, R. G. Kar Medical College, Calcutta became the first Life-member. The meeting terminated with a vote of thanks given by Dr. N. N. Das Gupta, the Vice-President of the Group. The Bulletin No. 2 also contained an announcement for a one day symposium on Photophysics and Photochemical Mechanisms in Photobiology, scheduled to be held on 14th September 1965 in the Lecture theatre of Saha Institute of Nuclear Physics. The Symposium was finally held in the auditorium of Bose Institute and was inaugurated by Professor S. N. Bose, the National Professor. Dr. D. M. Bose, Director of the Bose Institute, actively participated. The day is also memorable because it coincided with the Pakistan threat of attack on Indian soil. With siren roaring overhead the symposium continued. Professor S. N. Bose expressed his appreciation on the existence of such a Group whose aim was to create a forum for interdisciplinary exchange of ideas on problems related to the effects of ionising and nonionising radiation on biological systems. He said, "such an exchange of ideas is becoming more and more important in the present day context of atomic explosion and space research." The Symposium was truely interdisciplinary in nature where ten papers were presented covering the disciplines of Chemistry, Physics, Botany, Zoology and Medical Science by scientists working in Institutions in and around Calcutta. I am happy to say that Dr. Anjali Mukherji, Dr. S. B. Bhattacharya and Dr. S. P. Sen who had participated on that day are also contributors at this Silver Jubilee Symposium. The activities of the Group continued unabated. Indian Biophysical Society also came into existence by this time and Dr. D. M. Bose suggested if the two could be merged together. But that was not desirable as the Photobiology Group had slightly different perception and perspective and already affiliated to International body. In 1966 the Group had the opportunity to welcome CIP Secretary-General, Dr. Edna M. F. Roe of Chester Beatty Cancer Research Institute, London. She gave two lectures : (i) "Spectra-structure correlation in tumour inhibitory and related stilbene derivatives" at Jadavpur University and the second one as the Twentieth Acharya Jagadish Chandra Bose Endowment Lecture, at the auditorium of Bose Institute on "Studies on the mode of growth inhibition of ascites tumour cells by polyelectrolytes and natural gums." Dr. Roe showed keen interest in the activities of the Indian Photobiology Group. She also offered to take students to work in her laboratories. Dr. Shantoo Gurnani who was initially at the Regional Research Laboratory, Hyderabad and later moved to Bhabha Atomic Research Centre, availed of the opportunity to go to London to learn the technique of flash photolysis.

Within five years (1964-1969) since its inception, the Group could come into contact with many scientists of established fame. Professor David Shugar, Head of the Department of Biophysics, University of

Warsaw, Poland visited in 1967 and gave two lectures (i) Some chemical and biological aspects of photochemistry of nucleic acids" at CNCRC (published in Bulletin No. 7) and (ii) Model polynucleotides for studies on structure and functions of nucleic acids" at Bose Institute as Twenty-Second Acharya Jagadish Chandra Bose Endowment Lecture. We were expecting Dr. Shugar to be an active participate at this Silver Jubilee Symposium also but unfortunately he could not make it in time due to unavailability of air booking. Now he will arrive only after the Symposium. Professor G. S. Hammond, Chairman, Division of Chemistry and Chemical Engg., California Institute of Technology, Pasadena, U.S.A. was in town in 1968 and gave a lecture on "Reflections on Photochemistry", a joint programme with the Indian Chemical Society. Few other lectures in and outside Calcutta mainly during Science Congress Sessions were also organised such as (i) Photodynamic action of light on nucleic acids and bases—Dr. K. Shivram Shastry, Osmania University, Hyderabad, (ii) Energy transfer in photosynthetic units—Dr. Asish K. Ghosh, Bose Institute, Calcutta ; (iii) Photobiology of reproduction—Prof. S. P. Sen, Head of the Dept. of Botany, University of Kalyani ; (iv) Some aspects of radiation biology—Prof. N. N. Das Gupta, Professor of Biophysics, Saha Institute of Nuclear Physics ; (iv) Application of radiation biology in Medical Sciences—Major S. Basu, Professor of Radiology, N. R. Sircar Medical College. Indian Photobiology Group took initiative to publish two articles in *Science and Culture*, 1972 under the series modern trends in Photobiology (1) Recent trends in basic photochemistry in relation to Photobiology—K. K. Rohatgi, Jadavpur University, Calcutta ; (2) Modern trends in photobiology—Energy conversion in photosynthesis—Govindjee, Associate Professor of Botany and Biophysics, University of Urbana, Illinois, U. S. A.

During this period seven issues of IPG Bulletin were brought out and exchanged with other National Associations such as British Photobiology Group and Societe´ Francaise de Photobiologie. Initially the issues were produced in typed and cyclostyled form but from the eighth issue the Bulletin took a better look in a printed form. Activities of the Group were appreciated in the reports of the Secretary-General of CIP presented at the International meetings. In the next five years 1970-74, we were fortunate to have Professor E. Rabinowitch of University of Urbana, Illinois an authority on photosynthetic studies, whose basic researches in physics and chemistry of photosynthesis in plants are perfect examples of interdisciplinary approach. He gave a lecture on 'Primary Photoprocesses in Photosynthesis'. In 1971, Sir George Porter, FRS, NL, Director of Royal Institute of Great Britain and a Past President of CIP, gave a talk entitled "Recent progress in the study of some primary photochemical processes" during the Indian Science Congress Session at Chandigarh. The landmark in the activity of the Group during this period was the organisation of the first Photobiology Symposium entitled "Photochemical and Photophysical processes in biological systems." The symposium was held between Jan. 27 and 29, 1972 at the Indian Agricultural Research Institute, New Delhi in collaboration with the Institute and Jadavpur University and Jawaharlal Nehru University, under the sponsorship of University Grants Commission and Indian National Science Academy. Its success was mainly due to all out help and encouragement from Dr. M. S. Swaminathan, the then Director of IARI. The symposium was inagurated by Dr. A. R. Gopal-Ayenger, Emeritus Scientist, Bhabha Atomic Research Centre and Adviser, Deptt. of Atomic Energy, Bombay and was presided over by Dr. S. K. Mukherjee then a member of National Commission on Agriculture, New Delhi. Thirty six papers were presented grouped in four sessions. The activity was duly included in the Secretary-General's report, presented at the sixth congress. The proceedings and the full papers were published in the Proceedings of the Indian National Science Academy as a special issue. The period also noted the sad demise of Professor S. N. Bose, Dr. Edna M. F. Roe and Dr. E. Rabinowitch.

Since the first symposium in Delhi, national symposia are being organised at intervals of three years, in collaboration with a University. The second symposium was held in Kumaon University, Nainital 1975. Professor H. Mohr of University of Freiburg participated. His participation was funded by IUBS. It was inaugurated by Dr. R. K. Asundi, Dr. D. D. Pant, Vice-Chancellor, Kumaon University, himself a photophysicist looked into all aspects of the organisational work and also gave a plenary lecture on "Energy transfer reactions in chemical and biological systems". Professor H. Mohr gave a very stimulating lecture on "Control of plastid development and chlorophlly synthesis by phytochrome". Presence of Dr. Mohr amidst the participants generated a very healthy interaction. Many participants could discuss their problems directly with him. His visit established a permanent ties with Indian scholars and his laboratory paved the way for quite a number of young scientists to work under his guidance in Freiburg. Dr. U. C. Biswal and Dr. Mrs. Biswal of Sambalpur University and Dr. R. P. Sharma of Hyderabad University, Dr. V. K. Kochar and Mrs. Kochar of NBRI are some of our members who have benifitted from this interaction. Biswals are here with their band of research scholars as contributors. We still hold a very warm place in our heat for Professor Mohr. His book "Structure and functions of Science" which he presented us, speaks of sensitivity and clarify of his thought.

The third symposium held in Calcutta on Nov. 23, 1978, was inaugurated by Dr. B. D. Nagchaudhuri. The symposium was presided over by Dr. S. K. Mukherjee the President of the Society and Vice-Chancellor of Calcutta University. In Sept. 1977 a one day symposium was organised in Calcutta during the visit of Dr. Kazuo Shibata of Laboratory of Plant Physiology, the Institute of Physical and Chemical Research, Saitama, Japan. The symposium was specially devoted to the study of thermoluminescence as a tool for the study of development of photosynthetic apparatus. The participation of Dr. P. V. Sane made the programme complimentary. It was a pleasure to know Dr. Shibata, a plant physiologist in research but an artist at heart. During the evening visits at the strand, by the side of the river ganga or while walking along Chowringhee Road, he drew faces, chosen selectively from the maddening crowds, and with expert stroke transformed charcoal into life. He carried them back with him as momentos from Calcutta. In years' time, we received request from his students for good wishes on his retirement.

By this time Dr. G. V. Joshi, Head of the Department of Botany, Shivaji University, Kolhapur had become keenly interested in the society and had attended the Calcutta Symposium with his band of dedicated scholars. He invited the fourth symposium in Mahaballeswar, beautiful resort in the Eastern Ghats, in

April 1981. Professor L. O. Björn then the Secretary-General of AIP, attended this symposium to explore the possibility of holding a Workshop on "Effects of Ultraviolet Radiation on Plants" in 1982 in India. Dr. Viney Jain, (now Director of INMAS) National Representative at the EC of AIP had forcefully argued the case of holding an interim EC meeting in India. The proposal was accepted. Dr. Björn was keen on the issue because by this time there was considerable concern, all over the world on the likelihood of ecological imbalances created by possible depletion of ozone layer. The fluorohalocarbons under the influence of sunlight generate chain reactions leading to depletion of ozone in the stratosphere. In the event of ozone depletion, the ultraviolet radiation lying between 280 nm and 320 nm, designated as UV-B will leak through the ozone shield and thus expose the living biological systems to deleterious UV-B radiations. The United Nations Environmental Programme (UNEP) was interested in promoting research activities in this area and had approached AIP for initiating such researches. India, being near the equator, is likely to be affected more by ozone depletion. Professor Björn, ceased with this problem came to Mahaballeswar to spread the message and develop collaborative programmes, with active research groups in India working on plant systems. Dr. Pill-Soon Song, Editor-in-Chief of Photochem Photo biology also participated in the Symposium and gave an illustrated lecture on "Photobiology of stentor coeruleus" with the help of artistically done posters and movie film to emphasise the phenomenon of phototaxis. The symposium was inaugurated by the then Chief Minister of Maharashtra, Sri A. R. Antulay. Poona University and Shivaji University, Kolhapur, were cosponsors of the symposium. We have lost Professor Joshi but his spirit pervades in his students Leela Bhosale and S.H. Pawar, who have come today to contribute their mite to today's celebration.

The International Workshop on the Effects of Ultraviolet Radiations of Plants was organised by AIP jointly with Indian Photobiology Society at the Premises of Indian National Science Academy, New Delhi in Nov. 1-5, 1982. About 20 scientists, mainly from USA and Germany, specially invited for their studies on UV-B effects on plants, participated. About 30 Indian scientists actively participated. Because of the keen interest that Dr. A. P. Mitra has in problems of stratospheric ozone depletion and its possible consequences, his group from National Physical Laboratory in New Delhi gave full support scientifically and otherwise. Most of the credit for the organisational work goes to Dr. Anjali Mukherjee and Dr. G. S. Singhal of Jawaharlal Nehru University, New Delhi. The workshop was inaugurated by Prof. M. G. K. Menon, Member Planning Commission and Presided over by Prof. S. K. Mukherjee. Prof. L. O. Björn gave a welcome address on behalf of AIP. This workshop was a landmark in the activities of the Indian Photobiology Society and far reaching recommendations were drafted giving directions to the future researches on the subject. Recent observation of ozone hole over antarctica have alerted the whole community of nations on the impending danger of enhanced UV-B insolation and its effects on terrestrial and marine ecosystem.

The activities of the society has continued unabated with three day symposia in Hyderabad in 1985 jointly with the Central University, Hyderabad with the efforts of Dr. R. P. Sharma and Dr. D. Balasubramaniam and in Lucknow 1987 in collaboration with

National Botanical Research Institute with the efforts of Dr. V. K. Kochar and P. C. Joshi under the guidance of Dr. P. V. Sane. As an appreciation of the activities of Indian Photobiology Society. Prof. S. K. Mukherjee was elected as co-opted member of the Executive Committee of AIP in 1976. The Secretary, Prof. K. K. Rohatgi-Mukherjee was elected Vice-President of AIP in 1980 and as President of AIP in 1984, four year terms for each positions. She recently attended the 10th International Congress on Photobiology in srael as the President of the Congress. There she was elected as the Honorary member of AIP.

And today the time has come to assess our achievements and failures. The philosophy of interdisciplinary collaboration has spread. The society has active chapters in Calcutta, Kolhapur, Sambalpur, and Poona. The News Letter appears regularly twice a year. Since 984, a new format has been designed under the joint editorship of Drs. B. B. Bhowmik and Papiya Nandi. There are plans to start a journal entitled "*the Photons*" in very near future.

Plans are ahead to enlarge the activities of the society beyond the national borders, and to involve Third World and SAARC countries. Dr. T. Yoshizawa, the President elect of AIP for the next four years has also suggested the idea to form a Federation of South East Asian Photobiology Societies.

In the next few days we hope to have stimulating scientific programme with young scholars and Research Associates under the guidance of Drs. B. B. Bhowmik and Papiya Nandi working hard to make the Silver Jubilee year a memorable one. Dr. A. P. Mitra, Director-General, Council of Scientific and Industrial Research is the Chief-Guest. The title of his key note address is "Sun and Earth." □

Notes and news

Coal gas from coal

It is informed that coal gas from Dankuni plant will reach Calcutta from June 15 this year (1989). Although it was Dr. Bidhan Chandra Ray (Dr. B. C. Ray) who was the architect of this plant many years ago, it took a long time to implement the project. Dr. Ray made the blue print in 1960.

This plant was designed to obtain coal gas from coal and use it by and large instead of coal itself to keep the environment clean. In India, such a plant to obtain coal gas is the first and in Asia, the second next to China.

Coal gas is an ideal fuel not only for cooking purposes but also for industrial uses. It is also a perfect laboratory-gas fuel. Being non-polluting and comparatively a cheaper fuel, coal gas has no parallel. It is the most efficient fuel and does not leave a residue. It is wholly combustible.

Coal gas from Dankuni plant will reach Calcutta soon. But the immediate requirement will be to augment its supply. And as such, the infrastructure will be essential. The 176 km Durgapur-Calcutta pipe network can carry as much as 7 million cubic feet. It can also carry Dankuni gas. Presently, there is want of takers.

Having no association with smoke, coal gas is found most useful but unfortunately, coal gas cannot be fully utilized and a great part of it has to be bled in the air. This is for want of takers. The first thing, therefore, will be to ensure ready markets for coal gas. If not, it will lead to a colossal loss of the useful fuel.

Worried over the problem, the Oriental Gas Company at Rajabazar, which used to supply gas, launched a drive to persuade small and the medium-sized industrial units in and around Calcutta to switch to piped gas in place of coal and furnace oil.

There is necessity for such a drive because while Durgapur coal gas has takers in Durgapur also besides Calcutta, Dankuni gas has yet no purchasers in Dankuni. Obviously, the loss of coal gas may be colossal if the supply system is not adequate.

Coal gas does not emit particulate matter and also gaseous pollutants. Coal and oil have not these advantages.

To consume the gas by the large, pipeline renovation was considered as one effort. At present, gas distribution is made to Howrah through a pipeline travelling under a Howrah Bridge. In the wake of gas to be generated at Dankuni plant, a direct line from Dankuni to Howrah was felt essential so that consumers might use coal gas more readily.

Calcutta Gas Supply Corporation plans to extend coal-gas markets with a view to utilizing it in greater proportion. In a bid to overcome the fuel crisis, different speakers in a seminar recently held in Calcutta also emphasized on more uses of coal gas.

Coal gas is manufactured in Durgapur Project Limited (DPL) also. It will now be produced at Dankuni.

Coal gas is a by-product produced in connection with coke manufacture. Since coke has a large market, production of coke is to continue. Coal gas from both units may overcome fuel crisis if the supply is regular.

Production of coal gas in DPL is also to increase if old coke-oven batteries which were damaged in 1978 flood are all rebuilt. The coal carbonization plant at Dankuni will add more.

The commonest of the industrial users of coal gas include glass blowing, bakery, ceramic units and others. The gas pipelines can be connected to Mother Dairy, Britannia too. The urgent need will be to seek their orders. To increase market canvas on utilities of coal gas over other fuels will help. Assurances of steady supply of gas to the Consumers will be the next.

The Gas Corporation recently approached Calcutta Electricity Supply Corporation (C. E. S. C.) for using coal gas in place of oil in the boilers. DPL approached Alloy Steel Plant for buying gas.

Steel-rolling units are some of the prospective coal gas consumers. Till recently, rolling units are not using coal gas in their furnaces.

ACC Babcock Limited remained closed. Now it resumes. It can also buy a significant part of coal gas.

Switch to coal gas from the conventional fuels will cut costs in the industrial units, particularly in the steel rolling and ceramics and substantially reduced pollution of the environment. Therefore, piped gas can be an alternative to coal and furnace oil. In the perspective of pollution threat by the conventional energy sources, coal gas utilisation appears to be by far most interesting.

It is admittedly true that coal gas has a pivotal role in the energy system. □

P. C. Bhattacharyya

New Enzymes from Snake Venom

Snakes are the most familiar poisonous reptiles that are distributed world-wide. The most interesting feature of these reptiles, from the scientific stand point, is their venom. Much research work has been done on the composition of the venom, its biological effects, and the means with which it is delivered to the victim. Snake venom contain toxic substances which affect the tissues and blood cells of the prey. For the snake, the venom provides a means of self-defence or of subduing the prey. It has been, however, recently realized that snake venom can also serve as a source of several enzymes. Enzymes are proteins that are present in all living organisms and serve as biological catalysts that are responsible for converting one substance into another in living systems. Two new, interesting enzymes have been isolated from the venom of cobra snakes, at the Centre for Cellular and Molecular Biology (CCMB), Hyderabad. The two new enzymes degrade nucleic acids which are an important set of chemicals involved in heredity. The enzymes carry out this degradation at specific chemical bonds and can, therefore, be used to determine where such bonds are present in the molecule of the nucleic acid. No enzymes that would degrade the chemical bonds at which the two new enzymes act, are so far known. It is expected that these enzymes will find wide use as reagents for research in molecular biology and genetic engineering, and lead to development of new techniques for determining the structure of RNA (ribonucleic acid), one of the two types of nucleic acids present in all living organisms. □

CSIR News

Microbial Degradation of Some Pesticides

Chemicals for crop protection and pest control are being increasingly used in agriculture and public health programmes. Such large scale use of pesticides has posed serious ecological and human health problems. Health and environmental scientists have stressed the need for developing safe and efficient methods for detoxifying the pesticide residues from the environment.

Microorganisms, especially bacteria, are versatile and are capable of degrading a large variety of xenobiotics including pesticides. Microorganisms, therefore, offer a great hope in tackling the ecological problems related with the persistent toxic chemicals in the environment. Shri Ashok Kumar Singh, a CSIR research fellow while working at the Industrial Toxicology Research Centre (ITRC), Lucknow, attempted the isolation of bacterial strains capable of degrading some commonly used pesticides like malathion and endosulfan at high concentration and understanding the pathway of their degradation by the microorganisms.

Two organisms capable of degrading malathion co-metabolically were isolated from industrial effluents using enrichment culture technique. One of the isolated strain was found to degrade malathion up to 150 ppm in 28 h with ethanol (1.0% v/v) as an additional carbon and energy source. The isolated bacterium (M-3) identified as a *Pseudomonas* sp. was found to completely hydrolyze malathion to malathion monocarboxylic acid through the enzyme carboxylsterase. The other isolate (M-1) identified as an *Arthrobacter* sp. degraded malathion up to 50 ppm in 40 h in the presence of ethanol (0.5% v/v) as a cosubstrate.

A bacterium capable of degrading endosulfan up to 50 ppm in the presence of ethanol (0.5% v/v) as a cosubstrate, was isolated for industrial effluents. This brought about complete degradation of endosulfan (50 ppm) within 36 h. The isolated bacterial strain (ES-2) identified as a *Pseudomonas* sp. metabolized endosulfan into endosulfandiol which was identified by mass spectroscopy. ☐

CSIR News

Announcement

Applications or nominations (by Fellow Oranic Chemists) are invited for the Prof. T. R. Govindachari 60th Birthday Commemoration Award in Organic Chemistry. Applications/ Nominations giving bio-data (4 copies) inclusive of a Five-Page Summary of Original research accomplishments and a list of reprints must reach the Registrar, University of Madras, Madras-600 005 on or before *14-9-1989*. Each application or nomination must also be accompanied with one set of reprints of publications. The value of the award is Rs. 5,000/- and the award is to be made to a distinguished Indian Organic Chemist working in India with a minimum of 15 years of teaching-cum-research experience. Applicants are advised to get a copy of other terms and conditions of the award before forwarding their applications by sending a self addressed and stamped (Rs. 1.50) envelope to the Registrar, University of Madras, Madras-600 005. ☐

BOOK REVIEWS

Human Personality and the Cosmic Energy Cycle by Swami Mukhyananda. Published by Centre for Reshaping our World-View, Calcutta. Price : Cloth Rs. 40.00, Board Rs. 30.00

Swami Mukhyananda, an erudite scholar who keeps track of modern development in the world and an ardent student of ancient Indian scriptures, has tried to present an integral and whole picture of the entire experimential existence in all its aspects in this book. Though the main text of Swamiji's theme runs only through 54 pages another equal number of pages supplement the main text with notes and explanations.

It is not very clear for whom the book has been written. If it is for the western audience reading will be difficult beyond two to three pages. If it is for the Indian audience and un-initiate in Indian scriptural literature the situation is not very different. However, for a initiate, it is a good interpretation of the ancient knowledge in terms of modern developments. The author has based his presentation on the Taittiriya Upanishad, the relevant chapters of the Bhagvad Gita, Shatchakra Nirupana and the Vedantasava of Sadananda. The inspiration for writing was obtained from the complete works of Swami Vivekananda which were written almost a century back. A re-evaluation and re-interpretation in terms of the present understanding of the scientific thinking was very much due. Had the book been less interspersed by Sanskrit words and quotations, it would have made a more smoother English reading.

The author is very critical of western science as fragmentary. He cites several examples to support his arguments. However, it should be remembered that science developed as separate subjects or topics and now the time has come when the west is groping for unity amidst this diversity. Uppermost in the mind of scientists in all disciplines is this one aim in mind to look for this unity. The author himself cites some of the books where some attempts were being made in search of unity, and the western scientists had a open mind about eastern thought.

Author's exposition of '*pancha-kosha*', the arousal of '*Kundaline*' and the interaction of microcosm with macrocosm is quite explicit. The charts supplement the understanding further. However, chart 1 could have been presented better ; charts 3 and 4 seems to be original contributions and give a lot of information at a glance.

Though the get up of the book is quite pleasing enough, care has not gone into its production as the copy which was reviewed (a cloth bound one) had a number of pages bound in reverse. □

B. B. Baliga

Ionizing Radiation Exposure of the Population of the United States NCRP Report No. 93. Published by National Council on Radiation Protection and Management

It is the duty of any responsible government in the present day world to assess from time to time the exposure of its population to ionising radiation and estimate the magnitude of doses from various sources of radiation. Thus the National Council of Radiation Protection

(NCRP) of the United States brought out reports assessing exposure from national back ground in (No. 45) 1975 and from consumer products in (No. 56) 1977. A success of these earlier reports has prompted a comprehensive report on the subject which after introduction divides the subject into six parts as follows :

1. Public radiation exposures from natural back ground.
2. Occupational exposures.
3. Public radiation exposures from nuclear power generation.
4. Public radiation exposures from consumer products.
5. Public radiation exposures from miscellaneous environmental sources.
6. Public radiation exposures from medical diagnosis and therapy.

In the concluding chapter definite recommendation have been given for dose reduction and for improved data taking for the future.

The report contains a glossary of the terms used and a complete list of NRCP reports.

It is a very useful and handy booklet to have in any library and such information from other regions of the world and our country are also a crying need. □

B. B. Baliga

Letters to the editor

Ecotypic differentiation in *Indigofera linifolia* at germination level

Indigofera linifolia Retz, a perennial herb, is widely distributed throughout the hotter part of India to Ceylon and in other countries. The species occurs in both salt-affected as well as salt-free habitats over the Indo-Gangetic plains. On normal soils, it is found round the year whereas in salt-affected habitats fresh plants come up during July and August every year through germination of seeds.

Germination is an event through which the seedling enters from the safest to active but a vulnerable phase of life-cycle. The event starts with water imbibition which is adversely affected due to high salt content in the edaphic environment of salt-affected habitats[1,2]. Both percentage as well as rate of germination generally decrease with lowering of osmotic potential of Water in surrounding medium[3,4].

The aim of the present study is to understand the behaviour of populations of *I. linifolia* occurring in contrasting habitats, viz. saline-alkali and normal habitats in relation to various ions usually dominating the salt-affected habitats of the Indo-Gangetic plains.

Seeds of saline-alkali and normal populations were collected from mature inflorescences in March 1986, air dried and stored in polythene bags. Based on the ionic constitution of saline-alkali soils of the Indo-Gangetic plains, three concentrations of cationic species, viz. Na^+, K^+, Ca^{2+} and Mg^{2+} in combination with Cl^- and anionic species viz., Cl^-, HCO_3^-, CO_3^{2-}

and SO_4^{2-} in combination with Na^+ as the cation corresponding to the saturation point, field capacity and wilting point were used for the present study (Table 1). Germination studies were performed in petri-dishes[7] for assessing the effects of various ionic species at three concentrations as mentioned above. Petri-dishes, each of 5 cm radius and 2 cm height, were filled with 200 gm of air-dried garden loam well mixed with requisite amounts of respective salts to have the desired concentration of various ions in the soil. Acid scarification (dilute sulphuric acid) was given to seeds of both populations for removal of dormancy before beginning the experiment. Fifty healthy seeds were placed in each dish on the soil surface. The soil was moistened with distilled water and the moisture content of the soil was maintained at field capacity (16%) by careful weighing and adding requisite amounts of distilled water to the soil whenever necessary. The experiment was performed in triplicate along with a control in the laboratory under 8 hr of photoperiod with fluorescent light plus a 15-watt incandescent bulb at temperatures ranging between 30 to 32°C. The emergence of radicle was taken as the criterion for seed germination.

Increasing concentrations of certain ions lowered per cent germination of seeds in both populations. Germination in control was 70.00±5.19% in normal and 89.00±3.60% in saline-alkali populations. Among cations, Na^+ in general adversely affected germination of seeds of normal population. Among anions Cl^-, HCO_3^- and CO_3^{2-} at concentrations II and III were detrimental to seed germination of normal population. Concentration III of Na^+, HCO_3^- and CO_3^{2-} imparted a harmful effect on germination of seeds of saline-alkali population (Table 2). Consistently, low per cent germination of seeds of normal population of *I. linifolia* under Na^+, Cl^-, HCO_3^- and CO_3^{2-} treatments indicated higher susceptibility of normal population to ion toxicity. Relatively better germination of saline-alkali population *I. linifolia* under these ionic treatments reflected adaptation of this population to the adversities caused by the salts. It may be concluded that species of *I. linifolia* succeeded occupying salt-affected habitats by virtue of a pre-adaptation to salt-stress and the ions characteristically

TABLE 1 : Concentration of various ionic species (meq/100 g soil) used in experimental studies

	Ionic species	Salts used	Conc I	Conc II	Conc III
Cations	Na^+	NaCl	2.010	4.020	8.040
	K^+	KCl	0.048	0.096	0.192
	Ca^{2+}	$CaCl_2.2H_2O$	0.040	0.080	0.160
	Mg^{2+}	$MgCl_2.6H_2O$	0.028	0.056	0.112
Anions	Cl^-	NaCl	0.270	0.540	1.080
	HCO_3^-	$NaHCO_3$	0.810	1.620	3.240
	CO_3^{2-}	Na_2CO_3	1.012	2.024	4.072
	SO_4^{2-}	Na_2SO_4	0.151	0.302	0.604

I=Saturation per cent ; II=Field capacity ; III=Wilting per cent.

TABLE 2 : **Per cent germination of seeds of *I. linifolia* under different ionic treatments with soil moisture maintained at field capacity**

Treatment	Concentration	Per cent seed germination	
		Normal population	Saline-alkali population
Control		70.00±5.19	89.00±3.60
Na^+	I	40.00±3.60	64.33±4.50
	II	20.67±3.51	54.00±6.56
	III	13.67±2.52	33.00±4.58
K^+	I	71.33±4.04	84.33±4.04
	II	65.33±3.05	87.33±3.78
	III	66.00±3.60	83.67±4.50
Ca^{2+}	I	66.33±4.50	84.67±4.93
	II	68.00±4.58	82.33±3.78
	III	67.33±3.05	83.33±6.43
Mg^{2+}	I	67.67±7.02	87.33±4.72
	II	72.33±4.51	85.67±2.52
	III	71.00±5.00	89.67±4.04
Cl^-	I	57.60±2.64	66.00±4.00
	II	49.67±8.14	63.33±5.50
	III	40.33±7.09	59.67±4.72
HCO_3^-	I	48.33±4.04	58.67±7.23
	II	41.33±5.85	56.67±2.52
	III	18.00±3.60	49.67±6.51
CO_3^{2-}	I	44.67±4.72	59.33±6.10
	II	39.67±6.51	54.00±7.00
	III	17.33±4.04	32.67±3.51
SO_4^{2-}	I	64.00±6.24	80.33±4.51
	II	60.67±4.72	83.00±4.58
	III	53.33±4.50	83.33±3.21

Each value represents an average of three replicates with ± values as Standard Deviation.

associated to the salt-affected habitats of Indo-Gangetic plains.

The authors are thankful to the Head, Department of Botany, B. H. U. for laboratory facilities.

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Received : 6 October, 1988.

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Modern pollen spectra of BaraShigri Glacier, Great Himalayan Range, Lahaul-Spiti District, Himachal Pradesh

Modern pollen/vegetation relationships from the diversified plant communities growing in the alpine region of the North-West Himalaya have been done earlier[1] but information regarding pollen sedimentation over glacier surface vis-a-vis extant vegetation is lacking from the Himalayas. The present study provides an account on modern pollen spectra from the airborne sediments deposited over BaraShigri Glacier (32°16′ E lat. and 77°35″ N long), Great Himalayan Range, Lahaul-Spiti District, Himachal Pradesh.

The BaraShigri, a glacier of valley type descending about 5334 to 4115 m, terminates into the edge of the Chandra Valley[2]. It lies in the BaraShigri Range, a part of the Great Himalayan Range running north-north-west to south-south-east towards north of Pir Panjal Range. Lateral moraine deposits located below this glacier are running parallel to the BaraShigri Range. In addition, there are several deposits of terminal moraines, glaciofluvial and fluvial deposits. The detailed climatic data of this site is not available. In general winter is severe, long and continued from October to April. During this period, the whole area is covered by snow. The snowfall is about 12-20 m during winter. The snow starts melting from the end of May.

Taxa growing around this glacier are very scanty. The nearest taxa to the sampling site is *Polygonum affinie* forming patches over sandy soil here and there. Flood plain of the Chandra River about 1/3 km north of this glacier almost barren except the isolated patches of *Polygonum cognatum* and *Taraxacum officinale*. The mountain crest facing north and west towards the left bank of the Chandra River is comparatively more vegetated consisting of only non-arboreal elements like, *Potentilla anseriana*, *Geranium pratense* and *Draba setosa* on moist soil, grasses and *Juncus* along the stream margin. The nearest place growing trees is in between Koksar and Chettru towards 3 km west of the BaraShigri Glacier. Trees growing here are smaller in size (5-8 m) and comprise mainly *Juniperus communis*, *Betula jacquomontii*, *Rhododendron anthopogon*, *R. campanulatum* and *Sorbus acuparia*. The nearest alpine forest is located at about 10 km north-west in the Pattan Valley along the left bank of the Chenab river. In this valley, *Pinus wallichiana*, *Picea smithiana* and *Juniperus communis* form forest and gradually overtopped by the scattered trees of *Betula utilis* and *J. communis*. The nearest temperate conifer mixed woods occur in the valley of Kulu-Manali in the southern aspect of Rohtang Range. Here the high-level oak (*Quercus semecarpifolia*) with species of *Acer*, *Alnus Aesculus*, *Rhododendron* and *Fraxinus* together with *Cedrus deodara*, *Pinus wallichiana*, *Picea smithiana* and *Abies pindrow* occurs at about 1800 m above sea level. At altitude higher than this, *Abies Webbiana* is more frequent and still above occur *Betula jacquomontii*, *Juniperus communis*, *Rhododendron anthopogon* and *R. campanulatum*.

Three surface sediments were collected about 50 m distance each other along a horizontal transact slightly above the snout of the glacier which is located about 4.5 km south-east of the Chandra river. The material comprise wind-blown silty-clay deposited over the glacier and were collected through scraping by a knife. The samples were lebeled as G1, G2 and G3 indicating 'G' stands for glacier. All these samples were treated with HF and thereafter the usual method of acetolysis was followed for pollen analysis[3].

Surface sediments studied in the present investigation have shown very rich in pollen/spores in contrast to surface sediments analysed earlier from river terrace, lake shores, mountain slope and other sites from the dry-arid region of the North West Himalaya[1].

An interesting feature observed in the modern pollen spectra is the occurrence of pollen in high proportion of extra-regional arboreal temperate/subalpine elements along with a few pollen derived from non-arboreal local plants. The pollen of temperate/subalpine are represented by *Abies*, *Quercus*, *Picea*, *Pinus*, *Cedrus*, *Alnus* and *Juglans*. These taxa may be ascribed to their carriage by the upthermic winds from the valleys below or from the southern aspects of Rohtang Range and their sedimentation over glacier surface where surrounding local vegetation is sparse.

The local and regional elements represented by their pollen in these pollen spectra (Table 1) are *Juniperus*, *Hippophae*, *Ephedra Artemisia*,

TABLE 1 : Pollen spectra from surface sediments of BaraShigri glacier
(Values are in percentage in terms of total pollen/spore counted)

Arboreal Taxa	Sample Number G1	G2	G3	Non-Arboreal Taxa	Sample Number G1	G2	G3
Ephedra	1.51	0.18	—	Poaceae	5.05	3.97	2.25
Hippophae	0.50	0.18	0.20	Cyperaceae	1.01	0.37	1.43
Juniperus	2.02	0.75	5.7	Chenopodiaceae	1.01	0.37	1.02
Betula	0.50	1.32	1.02	Brassicaceae	1.51	—	0.61
Abies	10.10	1.89	3.28	*Potentilla*	0.50	—	—
Quercus	1.51	1.89	0.41	*Polygonum*	—	1.70	0.82
Pinus	53.53	69.31	51.90	Rosaceae	1.01	1.70	0.41
Picea	5.55	5.19	7.39	*Parnassia*	—	—	1.84
Cedrus	5.05	7.50	3.49	*Scrophularia*	0.50	1.32	0.20
Alnus	2.02	2.65	4.51	Apiaceae	—	0.18	—
Juglans	—	—	0.61	*Meconopsis*	—	0.18	—
				Oxyria	0.50	—	—
				Rumex	—	0.94	0.20
				Pedicularis	—	—	0.20
				Primula	1.51	—	—
				Artemisia	—	1.13	3.28
				Saxifragaceae	0.50	—	—
				Caryophyllaceae	0.50	0.18	—
				Verbascum	—	0.18	—
				Asteraceae	—	—	0.61
				Campanula	—	0.56	—
				Monolete Fern spore	4.04	2.27	8.21
				Trilete Fern spore	0.50	0.75	0.41

Pollen sum

Sample Number —	G1	G2	G3
Total pollen/spore counted—	198	528	487
Total arboreal pollen—	163	442	383
Total non-arboreal pollen—	35	86	104
AP/NAP ratio—	4.65 : 1	5.13 : 1	3.68 : 1

Rosaceae, Poaceae, Cyperaceae, Chenopodiaceae Caryophyllaceae, Brassicaceae, etc. In these, *Juniperus*, *Betula*, *Ephedra* and *Hippophae* are shrubby or scrubby elements ; *Artemisia*, Poaceae, Cyperaceae, Chenopodiaceae, Caryophyllaceae, Brassicaceae etc. constitute the floristic of alpine steppe. The poor representation of local or regional taxa despite the occurrence of a large number of diversified alpine taxa in the modern vegetation around this glacier is probably due to the fact that the taxa growing in alpine region are poor pollen producers. Perhaps no work has been carried out regarding production and dispersal phenomena of pollen-grains by individual taxa in the high altitude region. It is of general opinion that the pollen production by high altitude taxa are comparatively less in comparison with taxa growing at lower elevation[4]. It has been observed that at 2000 m elevation the total pollen value was about 10 times lower than in the low lands[5].

The present study would be useful to translate pollen spectra made from Quaternary sediments in terms of the past vegetation from the alpine region of the Western Himalaya. The data of this study could also be used to understand the oscillation of tree line and glacier. In such studies, the ratio of arboreal pollen (AP) and non-arboreal pollen (NAP) has commonly been used in the interpretation of fossil pollen spectra. Under prevailing climatic condition, the AP/NAP ratio ranges from 3.68 : 1 to 5.13 : 1 in the pollen spectra made just few meters above snout of the BaraShigri glacier about 4.5 km towards the left bank of the Chandra River near Chottadara. During cold phase, the glacier will advance which will lower the tree line by killing the uppermost trees and that in turn will cause an increase in NAP. A warm period will cause the change in opposite direction.

The present study also indicates that the ice core samples from existing glaciers would be suitable for pollen analysis when other type of sediments have been found very low or totally devoid of spore/pollen contents. Moreover, palynological data from dated ice core smpales could also be correlated with the events of moraine deposits to understand the rate of glacial movements. Several younger terminal moraines are better preserved around BaraShigri glacier[2] which would probably allow a more detailed deciphering of the Holocene history of glacial events in relation to vegetation change.

The author expresses his sincere thanks to the Deputy Director General, Geological Survey of India, Northern Region for accommodating him in the BaraShigri Glacier expedition team 1977 and providing him all facilities to collect samples.

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Received : 12 September, 1988.
Revised : 17 January, 1989.

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Abnormal wave motion in chromosomes with defective system of genes

Genes are discrete elements on the chromosome analogous to beads on a string. They are arranged in a linear order and are continuously oscillating about their equilibrium position with an energy which is governed by the nucleo-cytoplasmic interactions. In an analysis of the wave motion in chromosomes, it has been assumed[1] that the genes behave as point masses (diameter is of the order of several nm) arranged in a linear order to maintain the structural integrity of chromosomes, provided by their mutual interactions, which determines their motion. If one gene starts vibrating it does not continue with constant amplitude, but transfers energy to the others in a complicated way. The vibrations of individual genes are not simple harmonic because of this energy exchange between them. The two complementary strands of DNA can be viewed as templates for each other. Wave motions in chromosomes are modified to a greater or lesser extent by the presence of the defective genes. The defective gene product has been defined as a functional or regulatory impairment of cells metabolism.[2] Due to such defective systems, the wave pattern previously discussed by the author[1] no longer holds. (Abnormal chromosome is characterised here by defective masses of genes and anomalous force constants acting between them). The theory of the wave motion in chromosomes associated with such defective systems presents considerable mathematical difficulties and calls for simplified models. Complications further arise when force constants are perturbed by some external agency such as radiation, chemicals, etc. The over-all coupled motions of the chromosomes inside the nucleus change due to increase or decrease of chromosomal number[1]. The problem considered here concerns the motion of genes in a chromosome containing substitutional defects ; the normal and abnormal mode frequencies and vibrational amplitudes are derived. A detailed investigation of the effect of malfunctioning genes on the wave motions in chromosome might shed some light on the cancer problem.

To explain the phenomena of crossing over, inversions, deletions, etc.[1], the equations of motion of a one-dimensional ring of N genes are

$$m\ddot{q}_r - S(q_{r+1} - q_r) + S(q_{r-1} - q_r) = D_r q_r \qquad (1)$$

where r runs over the N values from

$$-(N/2)+1 \text{ to } N/2,\ q_{N+r} = q_r\,.$$

Here q_r represents the displacement of the rth gene from its equilibrium position and D_r is a difference differential operator which characterizes the chromosomal abnormalities due to malfunctioning genes, m the normal mass of the genes (mass of the fibers (DNA strands) is neglected) and S is the "force constant" assumed to be the same for each pair of adjacent genes. Difference equations (1) occur in the theory of discrete gene elements on the chromosome structures and can often be related to differential equations by some limiting procedure ; q_r in (1) is really only physically meaningful at certain discrete points on the chromosome, namely the ra, a being the intergene spacing.

In a chromosome containing normal genes ($D_r = 0$), the displacements can be expressed as a linear combination of the normal modes. There exist travelling wave solutions in which the genes vibrate with the same frequency and for these one can write

$$q_r(t) = q_j(0)\ \exp i\,(kx^0_r - \omega_j t) \qquad (2)$$

k is the wave number, x^0_r is the undisplaced position of the rth gene and $\omega_j = \omega_M \sin \frac{k_j a}{2}$, ω_M ($\equiv 4$ S/m) is the largest frequency of the genes which has been calculated (in case of the haploid complement of chromosomes in different organisms). $k_j = 2\pi j/Na$. In the absence of the malfunctioning genes, the unperturbed normal mode frequencies are doubly degenerate[1]. The allowed values of the wave number k are

$$k = \frac{2\pi j}{Na} \begin{cases} j = 0, \pm 1, \cdots\cdots \pm \frac{1}{2}(N-1) & [N \text{ odd}] \\ j = 0, \pm 1, \cdot\cdot \pm(\frac{1}{2}N - 1), \pm\frac{N}{2} & [N \text{ even}] \end{cases}$$

There will be N normal modes. kNa increases by $2N\pi$ or that

$$ka \rightarrow ka + 2\pi \,. \tag{3}$$

The dimensional constants $\{q_j(o)\}$ are to be chosen to satisfy initial conditions on the chromosome. The instantaneous gene displacements are shown in Fig. 1. (We are actually considering longitudinal waves, but the displacements are shown as transverse for ease of representation). The displacements for $k = \pi/a$ (which gives the maximum frequency) is shown ; alternate genes oscillate in antiphase, so that the midpoint of each DNA strand which is supposed to act as a spring is at rest.

To consider mutations due to the alteration of single genes (i.e. a single malfunctioning gene of mass M at the rth position in the linear array on the chromosome), the frequency equation can be written as[3]

$$\epsilon \tan \frac{\theta}{2} = \tan \left(\frac{N\theta}{2}\right), \tag{4}$$

where the mass defect parameter $\epsilon = 1 - Q$, Q is the relative mass (= M/m),

$$\sin^2 \frac{\theta}{2} = \frac{\omega^2}{\omega_M^2}, \tag{5}$$

ω_M being the maximum frequency in the unperturbed chromosome. The roots of equation (4) give the perturbed normal mode frequencies. The displacements satisfy the equation

$$q_{rs} = q_{os}\left(\cos r\theta + \epsilon \tan \frac{\theta}{2} \sin |\, r \,|\, \theta\right) \tag{6}$$

(new modes have been labelled by s)

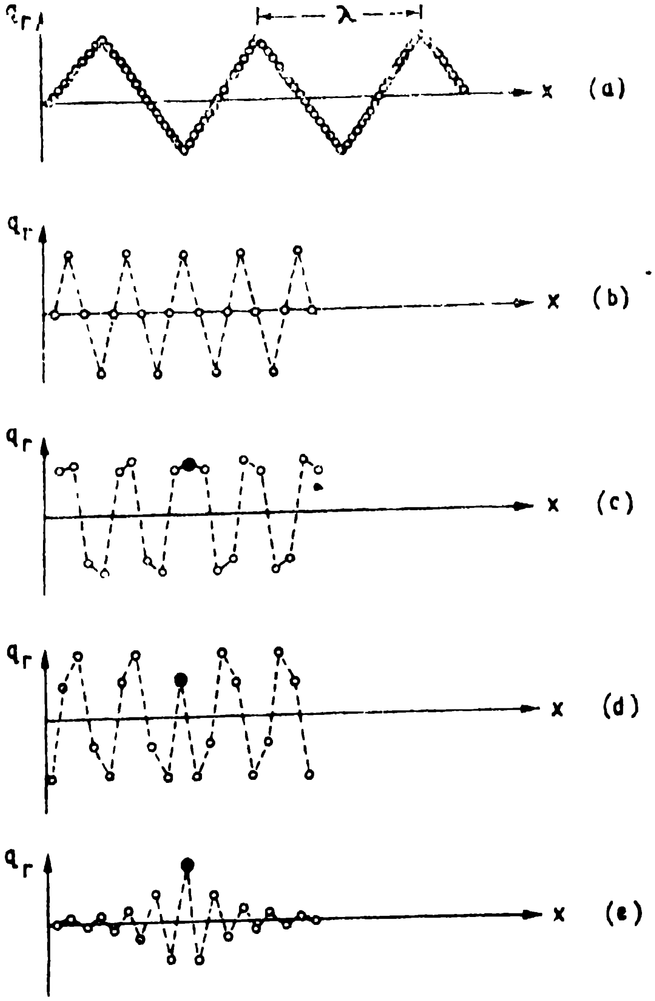

Fig. 1. Wave motion in chromosomes containing normal and abnormal genes : (a) represents the motion at long wave-length, (b)-(d) show gene displacements in frequency band mode ($\theta = \pi/2$), (e) shows a localized mode. The malfunctioning gene is represented by the big thick circle. The patterns with $\epsilon \neq 0$ are still wave-like, though some distortion, which characterizes abnormality, is found.

It is noted that in the case of the normal genes ($\epsilon = 0$), equation (6) gives only the symmetric modes, i.e. $q_{-r} = q_r$. The roots of equation (4) are $\theta = 2\pi j/N$ where $j = 1, 2, \ldots\ldots\ldots N/2$. Here we are using a standing-wave description, corresponding to a particular combination of the travelling waves given by (2). There are, however, an equal number of antisymmetric modes, $q_{-r} = -q_r$ which may be similarly enumerated. The number of distinct vibrational modes is the same whether one uses standing waves or travelling waves. (The total number of vibrations is $N-1$, since $j=0$ corresponds to a uniform translation of the chromosome[1]). It is now clear that when abnormal genes are present, the zero frequency mode which corresponds to a translational motion of the system is lost and the wave pattern discussed previously by the author no longer holds. An important consequence of this lack of translation of chromosome is an interesting aspect of abnormality to study cancer problem.

The antisymmetric modes have zero amplitude at the defect gene and, therefore, remain undisturbed by variations in its mass. The perturbation of the symmetric modes is given by the second term in equation (6). The frequencies of these modes are obtained from (5) with the help of equation (4). The solutions have different characteristics according to whether ϵ is negative or positive. If $Q > 1$, the perturbed frequencies all lie within the region 0 to ω_M. Each perturbed frequency is shifted slightly to a value below that of the corresponding frequency of the normal gene, but the shifts are small—of order $O(1/N)$, When N is very large (there may be hundreds or thousands of genes in every chromosome), the shape of the spectral distribution function is found to be unaffected by the presence of the defective gene mass[3].

If $Q < 1$, the perturbed frequencies are shifted to higher rather than lower values. Again, the shifts are small—of order $O(1/N)$—and each frequency is now limited by the next highest frequency of the unperturbed frequency spectrum. For $Q < 1$, one normal mode is missing. The reason is that the mode corresponding to $j = N/2$ and $\omega = \omega_M$ in the unperturbed chromosome has left the quasi-continuous spectrum to form what is known as a localized mode at a frequency ω above ω_M. The disturbance associated with this "lost" mode does not propagate as a normal wave and the value of θ is complex and accordingly, one can write[3] $\theta = \pi + i\varphi$. Generally, motions of all normal genes in a chromosome contribute equally to the energy in each normal mode. However, the genes which participate in localized modes are responsible for more than their normal share of the internal energy of the chromosome inside the nucleus. Hence, the region around an abnormal gene may be considered as a "fire spot" in the chromosome.

For large N, the frequency is finally given by

$$\omega^2 = \frac{\omega_M^2}{1-\epsilon^2} \,. \tag{7}$$

The only mode which escapes from the band is the symmetric one with frequency

$$f = \frac{\omega}{\omega_M} = \left[\frac{1}{Q}(2-Q)\right]^{\frac{1}{2}} \tag{8}$$

with $0 < Q < 1$. This mode goes back into the spectrum of normal frequency as $Q \rightarrow 1$. The effect of the defective genes on the vibrational amplitudes may be calculated from (6), which relates the displacement of a gene at r to that of the defect. For the modes with frequencies in the range 0 to ω_M which may be called the frequency band modes, θ may be regarded as a continuous variable (for sufficiently large N) in the range 0 to π. In Figs. 1a and 1b, normal wave motion in chromosome ($\epsilon = 0$) is shown. At long wave-length the motion of the genes approaches that of a homogeneous line (Fig. 1a). When $\lambda = 2a(k = \pi/2)$, motion becomes that of a standing wave, with the genes vibrating back and forth against each other (Fig. 1b). In Figs. 1c ($\epsilon = 0.8$) and 1d ($\epsilon = -2.0$), perturbed wave motions in chromosomes are shown. For $\epsilon > 0$, one normal mode is missing (Fig. 1c). For $\epsilon < 0$, the total number of solutions is correct though the waves are distorted (Fig. 1d). In Fig. 1e ($\epsilon = 0.2$), the localized mode at a frequency ω above ω_M (quasi-continuous spectrum) is shown. The gene amplitudes fall away rapidly, with increasing distance from a maximum at the defective gene.

The amplitudes of the genes for the localized mode (for large N), are given by

$$q_{rs} = q_{0s}(-1)^r \left(\frac{1-\epsilon}{1+\epsilon}\right)^{|r|} = -q_{rs} . \qquad (9)$$

Since $0 \leqslant \epsilon \leqslant 1$ the amplitudes q_{rs} fall off according to a geometric progression as r increases. The decrease becomes more rapid with increasing ϵ, until in the limit $\epsilon \rightarrow 1$ only the defective gene vibrates. The spatial concentration of the displacements in the immediate vicinity of the defect gene has given rise to the name "localized mode". The local mode frequency for $M \ll m$ can approximately be written as

$$\omega = \frac{2\,S}{M} . \qquad (10)$$

The mean square relative amplitude as a function of frequency (for $N >> 1$) can be expressed as

$$| q(0, \omega) |^2 = \frac{2\epsilon}{M(1+\epsilon)} . \qquad (11)$$

(The factor 2 arises from the degeneracy of the mode).

The amplitude increases as M decreases, since more of the vibrational energy becomes concentrated at the malfunctioning gene.

The knowledge of the wave motion in chromosomes which is affected to some extent by the presence of defective genes is essential for genetic engineering. The mathematical analysis of the detailed investigation of the effect of chromosome defects on the wave motion in chromosomes to study the behavioural pattern of mutational genes might shed some light on the problem of cancer (which is in progress). A single gene-malignancy relationship may exist in some malignant states, but there are many different kinds of malignancies[1].

The author wishes to thank Sri Sajal De for his help in the preparation of the manuscript.

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Received: 19 September, 1988.

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Effects of heavy metals (Water Pollutants) on the pattern of pollen germination of *Ottelia* and *Eichhornia* sp.

Metallic pollutants form a major component of the chemical toxicants which pollute soil, water and air. Some metals may exert toxic effects on somatic and reproductive tissue. Salts of some of these metals are found to be mutagenic in mammalian and plant systems. Reports on clastogenecity tests with mercury[1,2], lead[3-5] and cadmium[6-10] are well known. Some aquatic plants are known to absorb and concentrate various heavy metals from water[11-13]. The paucity of information regarding pollen abnormality (branching[14]) caused by water pollutants in plant system has led the present investigation. The assay of heavy metals as water pollutants on pattern and percentage of pollen shape, germinability and abnormality of Pollen tube in *Ottelia alismoides* (L.) Pers. and *Eichhornia crassipes* (Mart.) Solms has been made.

Ottelia and *Eichhornia* were collected locally and acclamatized in tap water tanks in our departmental garden for 30 days. The plants were then treated in earthen pots with molar solutions of 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}, 10^{-2} of $HgCl_2$, Hg_2Cl_2, HgO, $CdCl_2$ and $PbCl_2$ for 3, 6, 12 and 24 hr. The concentration of the chemicals and duration of treatments were selected from a earlier preliminary experiment. The solutions were maintained at pH 5.4. After the respective chemical treatment, the plants were transferred to tap water in earthen pots for recovery till flowering.

Ottelia flowered after 14-18 days (3 hr treatment), 20-26 days (6 hr treatment), 28-33 days (12 hr treatment) and 36-48 days (24 hr treatment). On the other hand, *Eichhornia* flowered after 10-14 days (3-day treatment), 14-18 days (6 hr treatment), 20-26 days (12 hr treatment) and 30-45 days (24 hr treatment). Treatments longer than 24 hr further delayed flowering and 7-day treatment showed no flowering at all. After flowering, the percentage of pollen-grain germination and pattern of pollen-tube morphology were recorded. Germination of pollen-grain was optimum at 12% sucrose in nutrient-agar medium in *Eichhornia* and 15% sucrose in *Ottelia*. After germination of pollen-grains, they were studied by acetic-carmine staining procedure[15] with a view to study the viability and nuclear behaviour in the pollen tube.

In *Ottelia*, control flowers showed 96% of germinability whereas 20-60% pollen-grains germinated in pollutant treated (10^{-2}M) plants. *Eichhornia* pollens showed 94% germinability in control but 40-70% in treated (10^{-2}M) flowers (Tables 1-4). In both plants, the control set showed straight pollen-tube but in treated sets pollen-tube showed different abnormalities (Figs. 1-8). In higher concentrations (10^{-4}, 10^{-3} and 10^{-2}M), the size of pollen-tubes were reduced 2-fold than control. On the other hand, in lower concentrations (10^{-6} and 10^{-5}M) the pollen-tube showed 2-fold increase over control. The breadth of pollen-tubes was also different in control (30 μ) and in treated sets (19.5 μ). Though the different configurations namely branching, twisting, and coiling were natural phenomena in some plants. In case of *Ottelia* and *Eichhornia*, these were quite unusual since these were absent in control but observed only in flowers treated with different heavy metals.

The lowering of pollen germinability in treated flowers indicated that these water pollutants ($HgCl_2$, Hg_2Cl_2, HgO, $CdCl_2$ and $PbCl_2$) had some adverse effects on germina-

TABLE 1 : Effects of heavy metals on pollen-tube morphology and pollen germination in *Ottelia* sp.

Chemical	Concentration (M)	Percentage of germinability				Percentage of pollen-tube with abnormality			
		3 hr	6 hr	12 hr	24 hr	3 hr	6 hr	12 hr	24 hr
	C	96	96	96	96	—	—	—	—
$HgCl_2$	10^{-6}	70	58	48	32	20	23	24	26
	10^{-5}	66	55	45	30	23	25	27	29
	10^{-4}	64	53	40	28	25	28	32	34
	10^{-3}	61	49	37	27	28	32	34	36
	10^{-2}	58	46	34	26	30	34	36	38
Hg_2Cl_2	10^{-6}	66	53	44	30	22	24	26	28
	10^{-5}	63	50	40	28	25	27	28	30
	10^{-4}	60	48	36	27	28	30	34	35
	10^{-3}	56	44	32	25	30	33	35	38
	10^{-2}	52	42	28	24	34	36	38	40
HgO	10^{-6}	54	50	40	27	24	28	32	34
	10^{-5}	50	47	36	26	26	32	35	36
	10^{-4}	48	45	30	25	30	38	39	42
	10^{-3}	42	41	26	24	34	40	44	47
	10^{-2}	46	38	24	22	38	44	46	50

TABLE 2 : Effects of heavy metals on pollen-tube morphology and percentage of pollen germination in *Ottelia* sp.

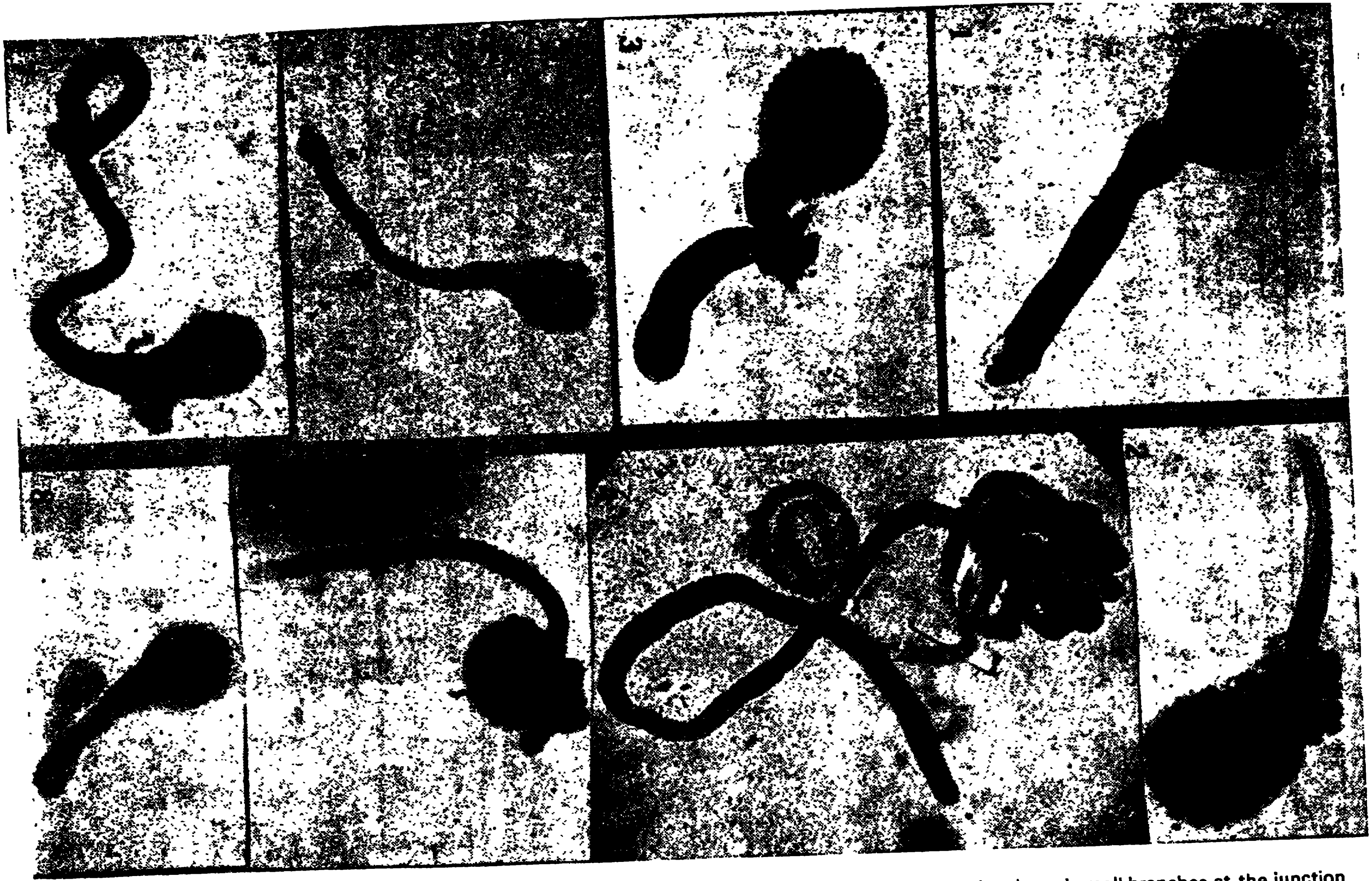
Chemical	Concentration (M)	Percentage of germinability				Percentage of pollen-tube with abnormality			
		3 hr	6 hr	12 hr	24 hr	3 hr	6 hr	12 hr	24 hr
	C	96	96	96	96	—	—	—	—
$PbCl_2$	10^{-6}	72	62	60	40	19	21	22	24
	10^{-5}	70	60	58	39	23	24	25	27
	10^{-4}	68	58	57	38	24	26	28	30
	10^{-3}	64	56	54	37	26	28	30	33
	10^{-2}	60	54	52	36	27	30	32	36
$CdCl_2$	10^{-6}	50	47	36	26	25	33	35	36
	10^{-5}	48	45	32	25	28	36	38	40
	10^{-4}	45	43	28	23	32	38	42	45
	10^{-3}	42	40	25	22	34	42	44	48
	10^{-2}	40	37	23	20	40	47	48	50

TABLE 3 : Effects of heavy metals on pollen-tube morphology and pollen germination in *Eichhornia* sp.

Chemical	Concentration (M)	Percentage of germinability				Percentage of pollen-tube with abnormality			
		3 hr	6 hr	12 hr	24 hr	3 hr	6 hr	12 hr	24 hr
	C	94	94	94	94	—	—	—	—
	10^{-6}	66	62	60	57	16	18	20	26
	10^{-5}	65	61	58	56	18	20	24	26
$HgCl_2$	10^{-4}	63	60	56	55	20	25	28	29
	10^{-3}	62	58	55	54	22	28	30	31
	10^{-2}	60	57	54	53	26	30	32	33
	10^{-6}	64	60	54	52	18	20	22	25
	10^{-5}	62	58	52	51	20	23	26	28
Hg_2Cl_2	10^{-4}	60	56	51	50	22	26	30	32
	10^{-3}	58	55	50	48	25	28	32	34
	10^{-2}	56	52	48	45	27	32	34	36
	10^{-6}	60	56	50	48	20	24	26	28
	10^{-5}	58	54	49	46	23	26	28	30
HgO	10^{-4}	57	52	49	44	25	28	32	34
	10^{-3}	56	50	44	42	28	32	34	38
	10^{-2}	54	48	42	40	30	35	38	40

TABLE 4 : Effects of heavy metals on pollen-tube morphology and percentage of pollen germination in *Eichhornia* sp.

Chemical	Concentration (M)	Percentage of germinability				Percentage of pollen-tube with abnormality			
		3 hr	6 hr	12 hr	24 hr	3 hr	6 hr	12 hr	24 hr
	C	94	94	94	94	—	—	—	—
	10^{-6}	78	76	70	64	15	16	19	20
	10^{-5}	74	72	66	60	16	18	22	24
$PbCl_2$	10^{-4}	72	70	62	58	17	20	25	26
	10^{-3}	71	68	60	56	18	22	28	30
	10^{-2}	70	66	58	54	20	26	30	31
	10^{-6}	57	55	46	44	24	28	32	33
	10^{-5}	54	50	45	43	26	30	34	38
$CdCl_2$	10^{-4}	50	48	44	42	28	34	36	40
	10^{-3}	53	46	42	41	30	36	40	42
	10^{-2}	52	44	41	40	34	38	42	45



Figs. 1-4. *Ottelia alismoides* (× 1200) : (1) Germination of pollen grain (Control) ; (2) Pollen tube slowed small branches at the junction of pollen grain wall & pollen-tube (6 hr treatment with 10^{-2} M HgO) ; (3) Pollen grain showed twisting and bursting at middle position of pollen tube (3 hr treatment with 10^{-6} M $PbCl_2$). of pollen tube (12 hr treatment with 10^{-4} M $CdCl_2$) ; (4) Elongation (2-fold) and twisting of pollen tube (12 hr treatment

Figs. 5-8. *Eichhornia crassipes* (× 1200) : (5) Germination of pollen grain (Control) ; (6) Small branches of pollen tube (24 hr treatment with 10^{-5} M $FbCl_2$) ; (8) Elongated and twisted pollen tube with 10^{-3} M $HgCl_2$) ; (7) Elongated 2 coiled pollen tube (6 hr treatment with 10^{-3} M Hg_2Cl_2).

tion process[14]. The elongation of pollen-tube at low concentrations indicated that the treated chemicals might have acted as promoter at the elongation zone. On the other hand, inhibition at higher concentrations showed a tendency to lethality, as 10^{-1} solution exhibited complete inhibition of pollen tube elongation. Of the two plants, *Eichhornia* was more tolerant to water pollutants than *Ottelia* (Tables 1-4). Among the mercuric compounds, HgO produced more deleterious effects than the other two. $PbCl_2$ was least toxic in comparison to mercury and cadmium.

The second author is thankful to the University of Burdwan for financial assistance.

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Received : 26 September, 1988.
Revised : 28 December, 1988.

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Heavy metal concentration of fish and prawn collected from Hooghly estuary

Heavy metals are well known pollutants in Hooghly estuary[8,10]. There are reports of considerable accumulation of different heavy metals in the sediment, fish and other biota in this estuary[3,12]. Heavy metal contamination of fish may cause serious public health hazard[6]. In the present investigation zinc, copper, chromium and cadmium have been estimated by atomic absorption spectrophotometer in 10 species of fish and one species of prawn captured from an industrial belt of this estuary to evaluate the fitness of these fishes for human consumption.

Fishes were captured during 1987 from a 15 km stretch of the Tribeni Industrial zone of the estuary which receives effluents from various industries[5,11]. *Mystus vittatus*, *Gobioides rubicundus*, *Puntius sophore* and *Ophiocara porocephala* were obtained in sufficient quantities. All of these species except the last one reach the local market regularly and are consumed by the local people. Other commercially important species captured were *Mastacembelus pancalus*, *Glossogobius quiris*, *Amblypharyngodon mola* and *Alicthys punctata* obtained in small quantities and one specimen each of *Liza corsula* and *Labeo bata* were available. In addition, moderate quantities of prawn *Penaeus indicus* were also obtained. Metal analyses were made by the method of wet digestion for whole body of small sized specimens and separately for muscle and viscera of larged sized specimen[2]. A composite sample of sediment[1,3] and water[1] collected from different zones also analysed for total metal concentration. Concentrations of zinc, copper, chromium and cadmium were determined by atomic absorption spectrophotometer.

Chromium and cadmium in both sediment and water were undetectable while copper and zinc were present in moderate quantities in the sediment (8-7 μg. Cu-g^{-1} and 10.63 μg. Zn-g^{-1}) and in low concentrations in water (2.09 μg cu/ml and 0.65 μg Zn/ml). Prawn accumulated a high amount of Zn and a trace amount of Cr and Cd (Table 1). Of the 10 species of fish analysed, high concentration of metals were

TABLE 1 : Heavy metal concentrations (μg-g^{-1}) for various species of fish and prawn. Mean values ± SD are given for each species and metal

Species	Sample size	Tissue	Zn	Cd	Cu	Cr
Fish						
Mystus vittatus	16	Muscle	13.98± 3.72	0.14±0.06	12.69± 4.06	4.54±2.03
		Viscera	34.61± 9.10	0.24±0.11	6.91± 1.14	9.93±4.44
Mastacembelus pancalus	4	Muscle	108.24±45.78	0.43±0.26	3.29± 0.94	3.42±3.42
		Viscera	286.21±63.83	ND	41.17±24.05	ND
Glossogobius guiris	2	Muscle	13.13± 9.23	ND	5.59± 2.21	ND
		Viscera	23.10±14.91	1.98±1.40	17.20±11.78	ND
Puntius sophore	4	Muscle	4.45± 1.87	ND	10.36± 0.44	ND
		Viscera	19.80± 3.21	0.96±0.56	9.91± 2.39	4.81±2.78
Ophiocara porocephala	18	Muscle	13.33± 2.12	ND	3.49± 0.53	ND
		Viscera	63.81±10.91	ND	37.99± 7.41	ND
Gobioides rubicundus	11	Muscle	17.52± 2.05	ND	17.67± 4.44	17.44±8.72
		Viscera	58.44±14.71	0.14±0.07	23.99± 0.56	1.65±0.83
Labeo bata	1	Muscle	ND	ND	10.05	ND
		Viscera	31.00	ND	94.65	ND
Liza corsula	1	Whole body	ND	ND	19.66	53.84
Amblypharyngodon mola	4 (Composite)	Whole body	83.86	0.38	13.17	ND
Alicthys punctata	4 (Composite)	Whole body	8.89	0.50	47.69	2.78
Prawn						
Penaeus indicus	6	Whole body	135.59±74.13	1.92±0.74	19.81	1.45±0.92

ND, Not detectable.

found in five species. Zinc concentrations were high in *Mastacembelus pancalus* and *Amblypharyngodon mola* while *Alicthys punctata* showed a high amount of copper. High concentration of chromium was detected from *Liza consula* and *Gobioides rubicundus*. Cadmium in all the ten species of fish were either not detectable or present in traces. *Mastacembelus pancalus* was the most contaminated fish. Highest concentration of Zn detected from the viscera of one of these fishes was 397.95 μg $Zn\text{-}g^{-1}$. This was even higher than the maximum concentration of Zn detected in prawn (369.92 $\mu g\text{-}g^{-1}$). The same specimen of *Mastacembelus* showed equally high amount of Zn (218.5 μg $Zn\text{-}g^{-1}$) in the muscle. In other species metal concentrations were negligible. Total length and weight of the fish irrespective of the species did not show any correlation with log concentration of metal. However, among 3 size groups of *Gobioides rubicundus* a negative correlation was found in between length or weight of the fish and log concentration of Cu or Zn in muscle ($r = -0.98$, $P < 0.05$). Such negative correlations are often found[4,9].

Survey conducted in this estuary during 1977-81 observed an accumulation of 381.6 ppm of Zn and 9.6 ppm Cr in the sediment, 120.4 ppm of Zn, 127.8 ppm Cu and 20 ppm Cr in fish and maximum 112.2 ppm Zn, 10 ppm Cu and 0.3 ppm Cr in shrimp[3]. The present observation shows a comparatively low deposition of Zinc in the sediment, but the biomagnification of some metals in some specimens indicates frequent exposure to increased concentration of these metals. Although muscle is not a suitable body part to determine the extent of heavy metal contamination of entire organism, metal concentration of muscles of a fish is important for its fitness for human consumption. In the present investigation concentration of metals in the fish muscle irrespective of the feeding habit, was found to be low except in *Mastacembelus* which showed a high concentration of Zn in the muscle. Musculature may become cariched by metals only when the contamination is high. High concentration of zinc detected in this fish and the prawn indicates the vulnerability of this zone of estuary for this metal as detected even more than a decade earlier[7]. This situation prompts to undertake regular monitoring of the estuary instead of being complacent for strict imposition of laws.

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Received: 2 November, 1988.

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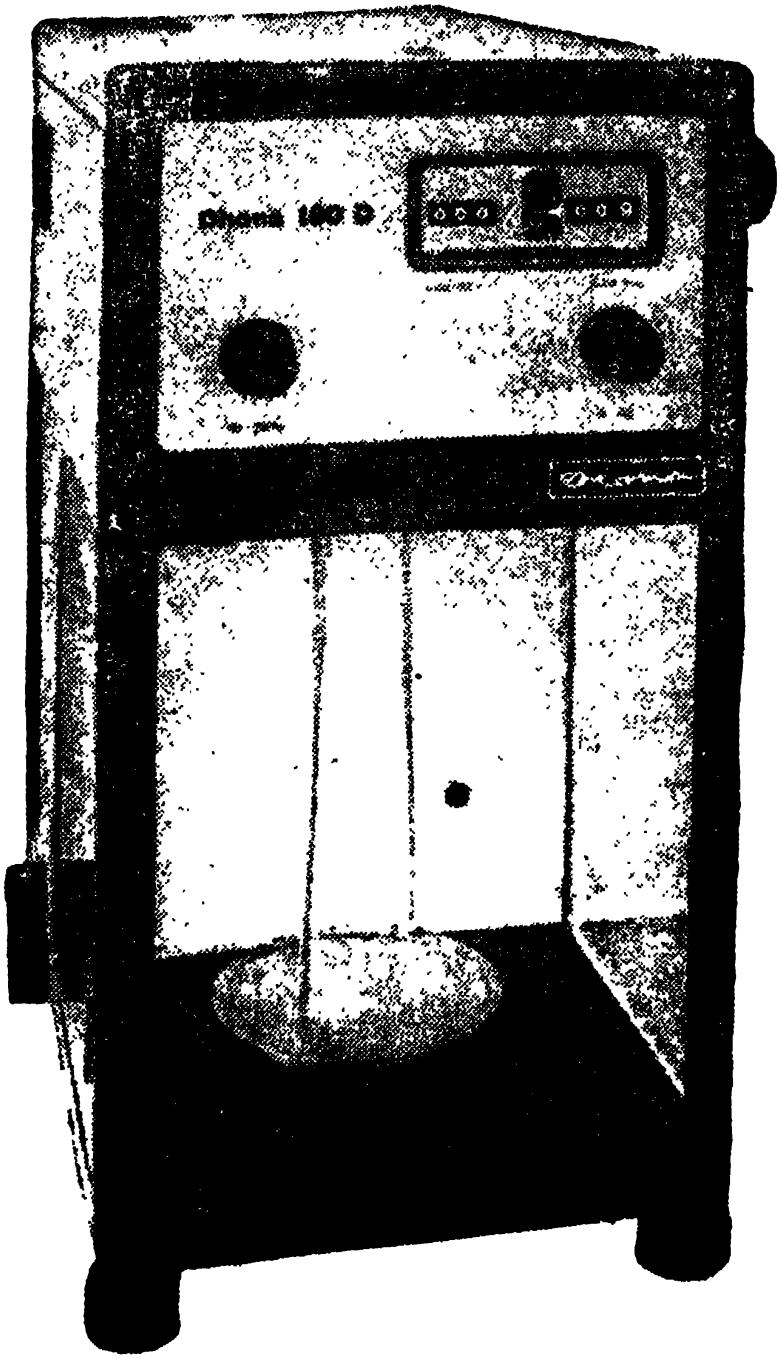

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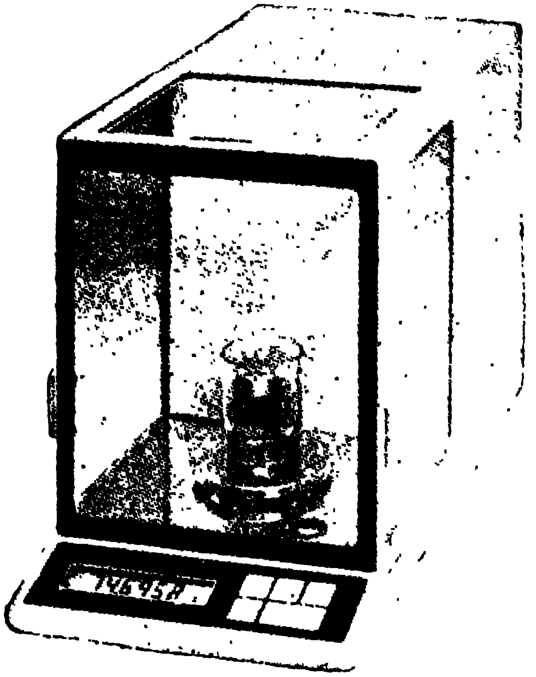

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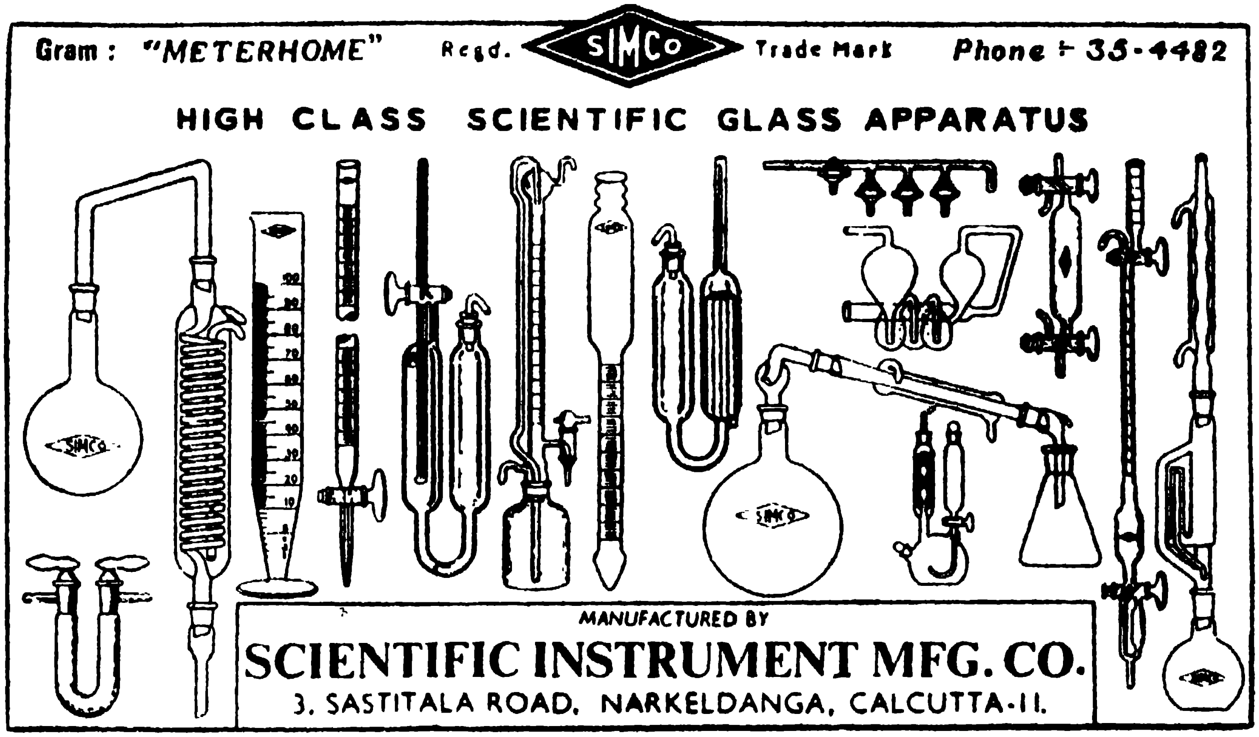

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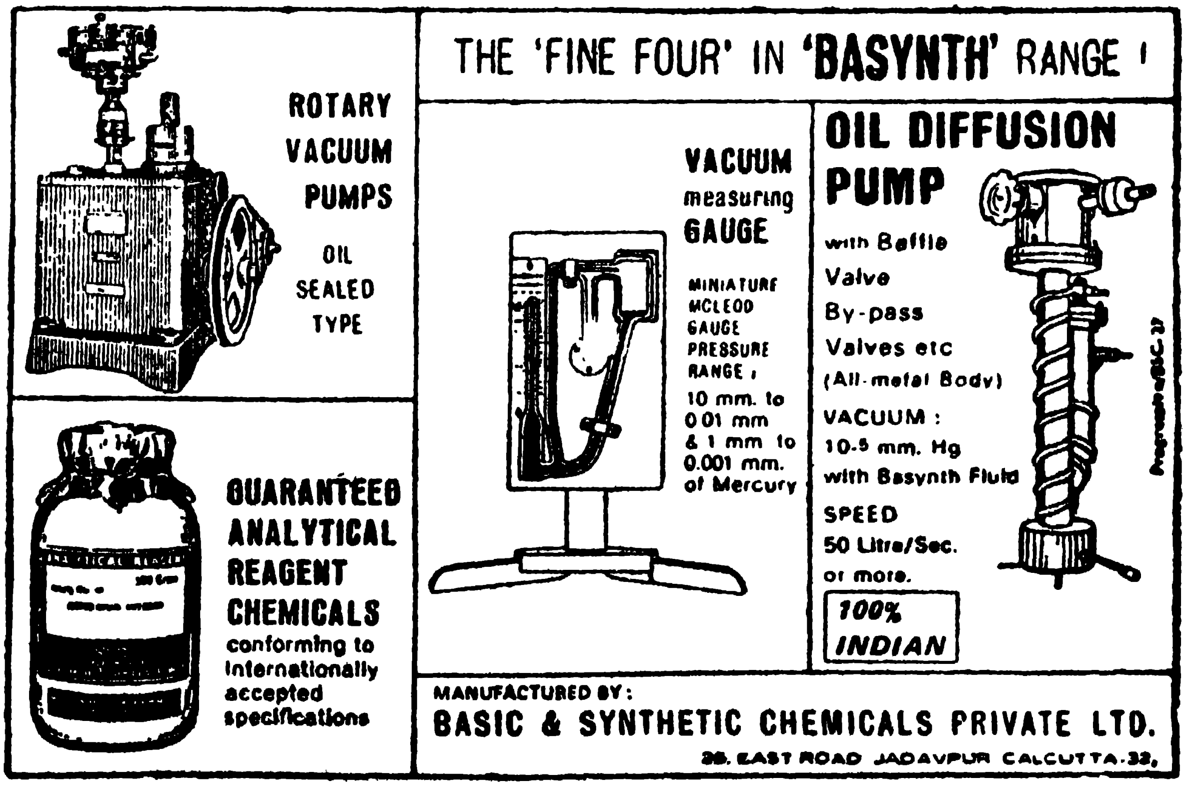

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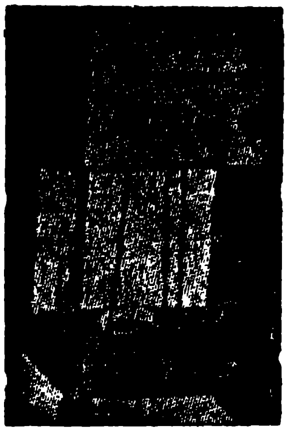

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SCIENCE & CULTURE

VOLUME 55 □ AUGUST 1989 □ NO. 8

DISASTERS—NATURAL AND MAN-MADE (I)

MAN has faced natural disasters ever since he started living in society. In a way he was prompted, nay compelled to live in society to face the calamities together. The force with which the storms lashes the earth, the energy with which the earth heaves and turns everything topsy-turvey as in an earthquake, or the fury of the flash floods which deluges everything in its wake, the vigour with which the water is evaporated from the earth parching it dry, devoid of life but silence in a drought, all are natural phenomena let loose with such tremendous energy that the combined strength of the society of man is no match to it. In different ages, man has tried to understand these varied phenomena and the surviving humanity has tried to compromise and developed a philosophy of life from which an individual can draw inspiration and build his aspirations for a safer and better life.

It may be that these early experiences of man which created a all powerful God in the image of man himself. The fury of nature was attributed to the anger of this Almighty let loose on the weakling human and the same was withdrawn when he was pleased. The sense of sin and the punishment for committing the same must also have the same root. Victims of natural calamities were considered to be punished for their accumulated sins by the Almighty and community worship or prayers gave solace to man. By and by, he came to understand that prayers are not a solution to combat nature but to study it patiently and systematically might lead one day for his release from its vagaries. This was the birth of science under which generations after generations accumulated their observations and inferences and built it into an in-depth understanding of nature. In the twentieth century alone science has made progress in leaps and bounds and man has acquired enough means to probe and interpret different natural phenomena.

Today, standing at the close of nineth decade in the twentieth century, man is not only still bothered by the natural calamities but also by some of his own doings. To consider it on a world-wide range will be too extensive and hence we will limit ourselves to the problems faced by our own country and try to assess to a certain extent our limitations of the present day knowledge, and means to combat (technologically) some of the regular disasters. In this and the following issues of *Science & Culture* we have collected articles by experts who have given their careful consideration to the various problems.

We start with the subject of storms, as India has a long coast line and the population is fairly dense which is subjected to these storms year in and year out. How have these been tackled by the government agencies and the private organisations to minimise the loss of life and property ? The behaviour of cyclones especially those originating in the Bay of Bengal, has baffled and fooled many an expert, and the crazy trail they take often, make one feel as if God is playing a cruel sport. In November 1987, initially poised to hit Northern Tamil Nadu, the cyclonic conditions changed its course and moved northwards giving jitters to Andhra Pradesh, Orissa and West Bengal before descending upon Bangladesh and left a death toll of about 50,000.

The new technological developments have made the Meteorological Department predict weather conditions and behaviour with accuracy especially from data relayed by orbiting satellites. These warnings given by the weather forecasters enable the authorities to take action well in time to move population living close to the shore to safer places, yet we can not get away from the helplessness over the destruction and suffering caused by cyclones. The mitigation of this agony borne by millions of people living near the shore lies in another sphere of life in the society. Majority of these shore residents are poor and live in ramshackle hutments which are totally defenseless against the caprice of the elements. As long as the living standards and quality of habitat are improved there will be no impact of administrations disaster management skill.

The second major natural disaster which has been dealt is the earthquake Earthquakes are caused by the release of internal energy of the earth from time to time. It is estimated that since 1000 A. D. down to this day, about 3.0 million innocent lives have been lost in these violent upheavals. Every year, on an average, about 21 major earthquakes occur and more than 10,000 people loose their lives. This natural phenomenon has been studied by geologist and good understanding has been obtained. The formation of Himalayas in the Indian sub-continent is attributed to the activity of earthquakes Geologists have now marked definite regions on the surface of the earth, which are earth-quake prone so that any man-made plan in those region could take account of this factor. Though geologists have classified the earthquakes into several kinds, the majority of the recorded earthquakes ($\sim$90%) are what are known as tectonic.

The development of the geological theory called 'Plate Tectonics' in recent years has clarified the underlying cause of earthquakes. According to this theory the earth's outer shell (lithosphere) is divided into a discontinuous rigid plate of about 80 km thickness moving in relation to each other causing such surface features as mountains, oceanic trenches, volcanoes and earthquakes The earthquake belts are all concentrated or are near the plate boundaries, where the relative motion of the plate is resisted by the frictional forces. When the strees increases to the point where it exceeds the strength of the rocks of the lithosphere, fractions occur causing upheavals on the earth's surface It has been estimated that each year strain energy equivalent to about 220 million tonnes of TNT generated by such forces is released in the form of earthquakes.

Seismologists and geologists have been able to map the region which are prone to earthquakes Today we know two well known seismic belts—one called the trans-Atlantic and the other circum-Pacific. Both cross at the corner of Assam and Burma, which is one of the most unstable seismic region in the world. The Assam earthquake of June 12, 1897, is considered as the biggest ever earthquake in the history of seismology. The destruction spread over an area of 3,71,200 sq. km and the shock was felt over 44,80,000 sq km. The intensity of the shock was so large near the epicentre that the shock waves were actually felt in a number of places. However, as the region was sparsely populated, the death toll was small.

Earthquakes do occur along the floor of the ocean which gives rise to seismic sea waves which Japanese call 'Tsunami'. These monstrous sea waves rise to several tens of meter in height and lash the coasts. One such terrific Trunami hit Lisbon in 1755. Waves with heights of 75 m swept around with a velocity of 650 km/hr. A part of the port was reduced to rubble within seconds. A staggering death toll of 60,000 was recorded Tremors of this earthquake were felt at thousands of kilometers away.

Though seismicity due to tectonic movements is well understood, frequent recurrence of tremors in and around dams and reservoirs lead the geologists to think that the hydrostatic pressure exerted by the impounding waters is the cause. But this latter phenomena could not be proved as at times tremors occur even when the reservoirs are empty. The earthquake near the Koyna dam region a few years ago, the recent earthquake near Bihar-Nepal border and the frequent tremors observed in the Idukki Reservoir site (which is far away from earth-quake prone zone) are indicators of the surmise. They have opened up new vistas in the study of seismology.

The Indian Meteorological Department collects information an earthquakes through a network of 17 permanent stations and four mobile stations besides seismological observatories at dam sites. They have up-dated the catalogue of major earthquakes in the country. The Department is capable of monitoring earthquakes of magnitude 5 and above occurring anywhere in the country. Shocks of lesser magnitude are registered only in areas where the observatory networks are dense.

Remote sensing by satellite is definitely a convenient method of detecting disasters near dam sites. In addition to the identification of regional tectonism on the basis of coastline oscillation, river migration and seismic activity, remotely sensed data can give more pertinent microlevel informations on such reservoir induced seismicity and the related stress in the rocks. These detection and warning systems particularly important as the area covered by the possible man-made and natural seismically-prone (from moderate to severe earthquakes), form about 55 per cent of total area of the country.

Floods and drought are other natural calamities discussed in this volume. With forty years of independence and seven five year plans we are yet to obtain any control over the yearly floods. Even with several multipurpose river valley projects the flood problem has been reduced to a certain extent in some regions but it is yet hard to say that we have got any control on it. Our water distribution system is still far from the desirable one. Most of the monsoon waters find their way directly to the oceans as adequate reservoirs and distributing canals are not there to contain them. Thus when monsoons fail or get delayed, quite a few places in the country have to face drought situation and drinking water becomes a commodity sought at premium. Though our reserve food stocks could take adequate care of the severe drought of 1987-88 the over-all situation was not a happy one.

For any country rivers are boons to prosperity. Those states are prosperous in India where many rivers flow. At the same time they also bring in misery when in spate. Especially this year with several North-Eastern regions reeling under the impact of ravaging rivers, the severity of the havoc may have few parallels. The total death toll is put around 1300 with Maharastra claiming practically half of it. Over five million people have been hit—either rendered homeless or deprived of their livelihood in the states of West Bengal, Orissa, Assam and Uttar Pradesh alone. The turbulant Brahmputra, the Barak and their tributaries have swamped food crops and tea gardens over an area of three lakh hectares. Each year, this area had to undergo a similar harrowing experience of successive waves of floods accentuating human misery and damage to irrigation sources and communication facilities.

According to the latest report of the Water Resource Ministry over 40 per cent of the 32 million hectares of flood-prone area identified as protectable to a reasonable extent has already been afforded the care. However, what has been obsetved in the recent floods in North-east region is that quite a few of these areas which are supposed to have been protected have continued to be vulnerable and the proneness to floods would seem to have grown in terms of the geographical areas as well as intensity. Even if the flood control effort by way of strengthening embankments, digging drainage channels and constructing similar other protection work is stream-lined and stepped up manifold, the basic causative factors behind the dangerously growing frequency and disaster-potential of the phenomena requires to be looked into in more realistic basis. The national flood control policy (Union Agriculture Minister in response to a Parliament discussion) should address seriously to the long term problem of unchecked denudation of forests in their river catchment areas, soil erosion and silting of the rivers which cut down the carrying capacity (hence frequency of floods and flash floods). Though Brahmputra Board and Ganga Flood Control Commission have plans for managing the excess flows in the various river systems, all depends upon how much has been executed. Unfortunately our national policies are such that implementations are patchy and they remain no more than declaration of intent.

(To be Continued in the next issue)

B. B. Baliga

CYCLONES OVER INDIA*

A. K. SAHA**

I thank the Indian Science News Association for inviting me to deliver the M. N. Saha Memorial Lecture for 1985. This is the first time that I have been invited to speak on an occasion associated with the memory of this great Indian though I have been associated with him in various other ways. I have responded to your invitation fully conscious of my limitations about being worthy of this task. I have chosen as my theme one of the many disasters that visit India very frequently—almost every year. The subject of natural disasters fascinated Prof. Meghnad Saha. This aspect of him is not so widely known. We know of his concern about floods and attendant human suffering. But his interest was much wider and enveloped the whole field of natural disasters. I remember the lecture he gave in 1934 at Allahabad immediately after the great earthquake of Bihar. I was a very young boy then yet I remember the lecture vividly. It was a wonderful study of the phenomenon illustrated by many historic anecdotes, containing also the explanation of the underlying physics and suggestions about possible methods of mitigation of the human sufferings caused. The lectures were profusely illustrated with slides and we listened spellbound.

Disasters

The word disaster comes from the Greek word astron, meaning stars. In the ancient world people believed that the stars were responsible for every thing that could happen to man. This belief has not been entirely removed though the wiser among us who believe in the discipline of the scientific method look for other explanations. The basic causes for most of the disasters are now fairly well understood. But when it comes to the question of predicting them there is much that still remains to be accomplished. We can classify broadly all disasters in two broad classes :

(1) Man made disasters, and

(2) Natural disasters.

MAN MADE DISASTERS : Under the first category we can list the following : Wars caused by political suspicion and economic causes—a possible nuclear holocaust which may be followed by what scientist call nuclear winter, terrorism caused by political causes and social instability, disasters caused by stupid destruction of the environment and ecology by poluting the air water and land in which we live and the senseless destruction of the various flora and fauna of this beautiful blue planet which probably is the only place in the solar system on which life has evolved. Much of this second type of destructive activity is no doubt caused by the enormous population explosion and the increasing demand for food, energy and material resources. This has led for example to such vandalism as the alarming accelerated pace of deforestation. There are possibilities of many other types of man made disasters such as the trend that is seen for favouring the practice of monoculture in agriculture because of the immediate advantage of high yield. There are many other types of man made disasters specially in urban areas like fire hazards in multistoried buildings. There are also such disasters as are met in the transport systems, bridge collapses and many similar things which can be included in the category of man made disasters. There are many other kinds of man made disasters.

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*M. N. Saha Memorial lecture of the Indian Science News Association delevered on 31.8.87.

**Emeritus Professor, Saha Institute of Nuclear Physics, Calcutta.

I do not propose to spend more time on them for my concern today is with the second class of disasters which are caused by natural processes, actually with only one member of this class. Before I introduce this member to you, I beg leave from you to rapidly review the various types of natural disasters if only to put you in a proper frame of mind to appreciate the dimension that such disasters can assume and the magnitude of human suffering they may cause. The principal members in this class are listed below :

NATURAL DISASTERS : Among this class of disasters I shall mention famines which are often man made but may also be caused by crop failure due to droughts, pests, industrial poisons, floods, gradual desertification and climatic changes due to senseless deforestation. Other types of natural disasters are dam bursts, epidemics, forest fires, mine disasters, earthquakes, land slides/subsidence, avalanches, tsunamies which are caused by tectonic processes under the sea bed, volcanic erruptions, tornadoes which are different from the main object of our interest today which is the phenomena of cyclones.

India has been visited by most of these types of disasters except volcanic eruptions and tsunamies. I should like to go over the historic records to acquaint you with some of the great killers recorded in the history of natural disasters.

Earthquakes : These are caused by the collisions of the various plates—six large and about six small plates which carry the continental masses. The continental drift theory and the 1960 plate tectonic theory on which this theory of earthquakes is based, is now well established. Many ways have been proposed to predict the occurrance of earthquakes but the success is by no means spectacular. Some of the methods of such forecasting are : Study of animal behaviour which generally is abnormal just before earthquakes, study of the hydrochemical precursers, temperature changes, study of the water levels in wells, emission of Radon gas from rocks, fluctuation of oil flows from oil wells, seismic studies, study of crustal deformations often now done by laser beam prospecting techniques, strain changes, study of tilt anomalies, study of electric currents in selected areas of land, study of magnetic anomalies and many other emerging techniques. Geographically earthquakes occur in well defined regions. A major earthquake is expected in the region of the famous St. Andreas Fault but this has not happened yet. It is estimated that on the average about 15000 people die every year because of earthquakes. In one single year 1976, about 2 lakhs persons were killed by earthquakes in China, Guatemala, Philippines and other parts of the world.

In India 55% of the land surface lie in earthquake prone regions. I shall now introduce to you some historic great killer earthquakes (Table 1). The list is very incomplete and left out many natorious killers.

Volcanic Eruptions : We may turn now to volcanic eruptions. Before I bring to you to the historic eruptions on earth I should like to mention one spectacular eruption out on our celestial companion—the Moon. There is record of a volcanic eruption in the region of the Giordano Bruno crater on the moon noticed by the priests of the Canterbury Cathedral in the 12th century. Recently the American space voyagers have

TABLE 1 : A selection of some historic famous earthquakes

1588 AD	*Northern Chima.* Dead 830000.
1737 AD	*India.* Dead 300000.
01. 11. 1755 AD	*Lisbon.* City destroyed. Dead 50000.
1703 AD	*Japan* Dead 200000.
1908 AD	*Messina* Italy. Dead 100000.
1811 AD	*Mississippi valley.* South of St Louis. Perhaps the greatest EQ in the new world.
28. 10. 1891 AD	*Nagoya* Japan. Dead 7279, injured 17393. Houses : total destruction 197530, partial destruction 78296, burnt 445, burnt and shattered 5934.
04. 04. 1905 AD	*Kangra* India. Epicentre 32.5 N76.5°E, Kangra and Dharmasala destroyed. Dead 20000.
1908 AD	*Messina* Italy. Dead 100000.
18. 04. 1906 AD	*San Francisco* US. Very famous EQ. Dead 700. Valuation of property destroyed $ 400 million.
16. 12. 1920 AD	*Kansu* province China Dead 100000.
01. 09. 1923 AD	*Tokyo, Yokohama* Japan. Fire destroyed 70% of houses in Tokyo 100% of houses in Yokohama.' Dead 99333, injured 103773, missing 43476. Houses : total destruction 128266, partial 126233, burnt 447128, washed away 868. EQ followed by fire and tornado.
25 05 1927 AD	*Kansu* province China Dead 100000.
15. 01. 1934 AD	*Bihar-Nepal border.* Epicentre 26 6°N86.8°E Dead 10000.
25. 01. 1939 AD	*Near Chillan* Chili Dead 25000.
15. 08. 1950 AD	*Assam* India Epicentre 28 46 N96.66°E. One of the most disastrous EQs recorded. EQ accompanied by land slide and flood. Dead : from EQ 156, from flood 552.
27. 03. 1964 AD	*Prince William Sound* Alaska. At 1736 hr Alaska time. One of the most violent EQs of modern times. Energy release about twice that of the San Fransisco EQ. Epicentre 129 km from the city about twice that of San Fransisco EQ. Epicentre 129 km from the city Anchorage. Sea bed lifted 40 m. Accompanying tsunami struck many parts of Alaska. At Valdez sand spldshed to a height of 67 m. At Whittier 31.7 m wave recorded. Tsunami reached Kodiac at Aleutians at 1830 hr. Tsunami wave 9 m Tsunami reached Halo 5 hr 24 m after EQ. Dead 131. Property damage estimate $3127900. Extensive damage at British Columbia, Washington, Oregan states. Property at city Crescent in California damaged estimated at $7414000.
14. 12. 1972 AD	*Managua* Nicargua. Dead 10000.
04. 02. 1976 AD	*Guatamala.* Dead 20000.
04. 02. 1975 AD	*Haicheng* in Liaoning province in China. EQ successfully predicted Massive evacuation before EQ saved lives.
04. 1976 AD	*Tangshen* China. This EQ could not be predicted. Dead 240000.
20/1. 09. 1985 AD	*Mexico.* First two EQ waves on 20th were of strengths on Richter scale 7.8 and 7.3. Third wave on Richter scale 4.5 followed on 21st. Epicentre roughly 400 km SW of Mexico city. EQ followed by tidal wave 20 m high on Mexico's Pacific coast. Dead 40000. Extensive damage to property.
10. 10. 1986 AD	*Salvador.* Shortly after 1200 AM. Continued for more than 5 hrs. Strength on Richter scale 5.4 for first wave followed by later tremors of strength 4.5-4.9. Dead 1000.

recorded many such volcanic eruptions in particular on some satellites of some of the greater planets of the solar system. I give below a selection from some of the famous historic terrestrial volcanic eruptions (Table 2).

TABLE 2 : **A selection of some historic famous volcanic eruptions**

24. 08. 0079 AD	*Vesuvius.* The cities Pompeii and Harculaneum were totally buried under lava and ash. Vivid account was given by Pliny the younger of the eruption which caused the death of his uncle Pliny the elder.
1783 AD	*Mt Skapter* Iceland. Dead 9000 about 1/5th the population of Iceland Cattle lost 23000.
07-17. 04. 1815 AD	*Volcano Tambora* on Is Sumbawa Indonesia Dead 90000.
25-27. 08. 1815 AD	*Mt Krakatoa* in Sunda Str. Indonesia. Major eruption occurred at 1020 hr on 27th. Accompanying tsunami swept coasts of Java and Sumatra. 21 cukm of lava and ash was blown off leaving a caldera 8 km wide and 244 m wide The tsunami destroyed 300 towns and villages. Gun boat at Sumatra was carried 3.2 km inland. Tide gauges at France and England recorded rise of sea level. Noise heard at Madagaskar. Spectacular twilights seen for the following decade. Estimated to be equivalent to an atomic blast of 100-150 Megaton. Dead 36500.
08. 05. 1902 AD	*Mt Pelee* on Is Martinique. City St Pierre destroyed. Dead 40000.
1914 AD	*Volcano Sakurajima* in Kagoshima on Bay of Japan. Successfully predicted. Massive evacuation saved lives
05. 1980 AD	*Mt St Helena* Washington USA. Successfully predicted.
14. 11. 1985 AD	*Volcano Nevada del Ruiz* Columbia. Eruption was predicted and evacuation plans were being prepared. Town Armero obliterated. Dead 23000, injured 25000. Subsequently there were flood and avalanche

Tsunamies : Tsunamies is a Japanese word meaning large waves at a harbour. As stated already tsunamies are caused by tectonic processes under the sea bed. The waves travel great distances on the ocean surfaces at speeds 300-1000 kmph. Wave lengths are of the order of 160-950 km. The tsunami waves on the open sea are often too small to be detected, but when they approach shallow waters they can be truly awe inspiring. Tsunamies may strike the land with forces of the order of 60 tonnes per sq meter. The first sign of a tsunami is the withdrawal of the sea from the coast which then returns and strikes the coast often as many as 8-10 times. I shall give a selection of the historic tsunamies in Table 3.

Before I go on to cyclones I shall refer to a rare type of natural disasters arising from impacts by celestial bodies like asteroids meteorites comet heads etc. I shall list some of the spectacular craters on earth (Table 4) which can be still seen not entirely obliterated by erosion processes on earth or impacts which remain in living memory.

I shall refrain from presenting you with some of the other types of natural disasters, for you may have formed an impression in your minds that your lecturer today is a person who takes ghoulish pleasure in collecting tales of natural disasters and human tragedy and woe. Indeed I am fascinated by disaster of any kind.

In 1968, I attended the annual meeting of the British Association which is a body

TABLE 3 : A selection of some famous historic tsunamies

1500 BC	*Is Thera* in Crete also called Stroughly and now known as Santorin. Volcanic eruption left a caldera of area 83 sqkm and 396 m deep. Ash layer was 39.6 km deep. Accompanying tsunami washed pumice stones to heights upto 259 m in Is Anaphi 24 km away. May have destroyed the Minoan culture once for all. Material removed 5 times greater than the Krakatoa explosion and the thermal energy 3 times larger.
573 BC	*Helice* Corinth. Town totally destroyed.
074 BC	*Potidae* Greece. City hit by large wave.
04 08 1498 AD	*Str Broca de Sierge.* In his 3rd voyage Columbus saw a sea wall rising to great height and then subsiding.
1692 AD	*Port Royal* Jamaica. Town plunged into sea after being hit by sea waves
1701 AD	*Japan.* Dead 30000. Boats destroyed 1000.
06. 10 1737 AD	*Cape Lopatka* Kamchatka, Siberia. Perhaps the greatest sea surge ever recorded. Surge height 70 m.
1755 AD	EQ at *Lisbon* caused a tsunami which washed over coasts Morocco, France, England and West Indies. Wrecked the ship in which Voltaire's Candide was passenger. Dead 10000.
1783 AD	*Italy.* Dead 30000.
28. 08. 1815 AD	*Mt Krakatoa* explosion. Tsunami has been described in Table 2.
1896 AD	*Sanriku* Japan. Under sea EQ at 149 km east of Honshu caused a tsunami which struck at 0800 hr. Height of surge at Sanriku was 30.5 m. San Fransisco recorded tsunami 10.5 hr later Dead 27000, injured 900. Houses destroyed 13000.
1933 AD	*Sanriku* Japan. Dead 30000. Dead 3000. Houses destroyed 9000. Boats upset 8000.
1958 AD	*Lituya Bay* Alaska. Biggest recorded tsunami. EQ caused 91 million tonne rock/ice fall from a glacier 305 m down into water causing waves scouring all trees/soil from a mountain on the opposite coast to a height of 524 km.
1946 AD	*Is Unimac.* EQ at Aleutians Trench caused tsunami with waves 30.5 m high destroying light house on Is Unimac 113 km from Kawala Bay on North Oahu in Hawaii.
1976 AD	*Mindano and Sulu archipelago* Philippines. EQ at Moro gulf caused tsunami. Dead 8000. Property damage estimate $100 million.

TABLE 4 : A selection of some major impact produced craters on Earth

200 million years ago	Lake Manicougah, *Quebec.* 80 km across.
1 3 million years ago	Bosumtii, *Ghana.* Diameter over 10 km.
	Sudbury Basin, *Ontario.* 140 km across
	Vredefort Dome, *South Africa.* 140 km across.
50 thousand years ago	Baringer Crater near Winslow, *Arizona,* Diameter : 1 km, depth : 200 m.
20 thousand years ago	Ajanta Lonar crater, *India.* Diameter : 1.5 km, depth : 150 m, rim : 25 m above surrounding level. Impact energy estimated equivalent to 2 megaton atomic blast.
06. 1908 AD	R. Tanguska, *Siberia.* "59 sq miles of forest burnt. No impact crater. Impact energy estimated equivalent to 12 megaton H bomb. Perhaps caused by impact with comet head.

similar to our Science Congress. The focal theme was Disasters and there was a major discussion on the tragic collapse of the bridge on river Fey. This interest of mine was heightened when I was invited by the Government of India to chair the Cyclone Review Committee. This committee was constituted in March 10, 1979 and submitted its report to an interministrial/interdepartmental meeting on 3rd May 1985 and to SACC on 16th November 1984. So far as I know the DST is trying to implement the recommendation of the committee through the various departments and agencies of the Government of India. I have learnt all that I know about cyclone at the meetings of the committee and some studies which were necessary for participation in the work of the Committee.

Cyclones: What are cyclones? They are storms forming over tropical seas. In this respect they have to be distinguished from the tornadoes which are far more tightly compact structures whose genesis is over land and whose life time are spent entirely over it. Structurally cyclones are large vortices in the atmosphere extending to 15-1000 km in lateral extension and rising 1-10 km vertically, with fierce winds spiralling round a centre. Fully developed cyclone can move as much as 350-450 km per day and wind speeds in cyclone systems could reach to values as much as 350-450 km/hr. They are generally generated between latitudes 5° and 15° in either hemispheres. They occur every year over the Atlantic, the Pacific and the Indian Oceans. The South Pacific is free from these storms. These storms over the Atlantic are known as hurricanes after the local name given by the Amerindian tribes living on the Carribean Islands. Over the Pacific these are known as typhoons after the Chinese word for great winds. The Indian word Toophan, which occurs also in persian, comes from this Chinese word. The word Cyclone was coined by Henry Piddington, Chairman of the Marine Court at Calcutta in 1848, deriving it from the Greek word meaning coils of a snake. Considering the spiralling winds and rain bands coilling the centre of the storm, this name is certainly most appropriate.

Early Cyclone Research

Among the early observations on cyclones mention must be made of the 23 memoirs published by Piddington during 1839-1851. Two English contemporaries of Piddington, Meldrum and Thom analysed the cyclones on South Indian ocean. Piddington's 'Sailors Hand Book of Storms' is still used by Mariners. H. F. Blanford the first Imperial Meteorological Reporter to the Government of India (1875-1899) and Sir John Eliot the first Director General of Observatories (1899-1903) prepared histories of the disasterous Indian cyclones that occurred in the 19th century. Sir John's report on the 1864 Masulipatnam and the 1876 Backergunge cyclones excited so much attention that they were placed on the table of the House of Commons. These pioneering researches by British meteorologists were continued by American metcorologist Gherji of the Shanghai Observatory and other workers. All these early works were based on ship observations.

I shall later in this lecture read out from the ship log of one of the ships on the Bay of Bengal during the 1876 Bakergunge cyclone which was one of the most devastative cyclones ever recorded.

Characteristic Features of Cyclones

I shall now describe the main features of cyclones and its genesis, evolution and life history. Tropical oceans are seed bases of cyclones but generally cyclones cannot form within 2°-3° of the equator due to the extremely weak Coriolis force there. On the Arabian Sea and the Bay of Bengal cyclones generally form between latitudes 5°N and 15°N. However, some cyclones are known to form at very low latitudes 3°-4°N. Cyclones are five times more frequent on the Bay of Bengal compared to their occurrance on the Arabian sea. I shall now discuss the general nature of cyclones. The main mechanism of feeding energy to cyclones is the pick up of warm moisture from the waters of tropical seas, and a sea surface temperature of 27°C is considered most favourable for this process. The source of the immense energy of cyclone systems is the cumulus cloud tower over the cyclone field releasing their latent heat. Most cyclones die out on the sea, but many cross over to the land and cause enormous devastations. The crossing over to the land is called landfall. Cyclones that landfall rapidly loose their energy and their characteristic structure. In this respect they are different from the tornadoes which are generated on land and because of their more compact structure they keep their shape and structure while travelling over large distances on land. However, some time cyclones that originate in the Bay are found to cross over the landmass on the narrow lower end of the Indian peninsula reaching the Arabian sea where they may gain energy once again from the sea and intensify. Similarly, some of the Bay cyclones are later intensification of some of the typhoons which had weakened and wandered into the Bay from the China sea.

Life History of Cyclones

In USA, the organisation NOAA (National Oceanic and Atmospheric Administration) records time elapsed pictures of the hurricanes, tornadoes, forest fires and other natural disasters as viewed from satellites. It is fascinating to watch these time elapsed films which reveal in a few minutes the entire evolutionary sequence of these natural phenomena from the birth to the termination. Cyclones can pass through 4 phases though not necessarily through all of them. The first phase is the initial formation over low pressure areas which often appear over the sea during the cyclone seasons. The actual mechanism of the development from this initial low pressure stage to the cyclonic stage is not quite clear and such a development does not always take place. The necessary conditions seem to be :

1. Sufficiently large area of sea surface with temperature above 20°C should be available.
2. The Coriolis force must be over a certain threshold which excludes a belt of 5° on either side of the equator.
3. Presence of a weak vertical wind sheer in the basic current is necessary.
4. Pre-existence of a low level disturbance in the region of upper level divergence or outflow above the surface disturbance is necessary.
5. Other requirements are : Presence of large cyclonic vorticity, high middle level humidity and 15°C or more fall of equivalent potential temperature between the surface and the 500 mb level.

The initial formation may go on to concentrate standing stationary for 3-4 days drawing energy from the sea surface. The central pressure may then fall by 3-5 mb and the wind speed may go up to 40 kmph. The cloud bands will start spiralling round the central area and there may be occasional squalls and rough seas. This stage is called Depression. When the central pressure falls further, the Deep Depression stage is reached. The next development may be the true cyclonic state. The whole formation may now start moving to the north-east or even northerly direction, picking up copious moisture from the sea surface and continuously intensifying. The central pressure may now fall by 20 mb, the wind may reach gale force ; the sea may become very rough and frequent heavy squalls may occur. The cyclone is not yet dangerous at this stage Two-thirds of the cyclones that hit the Indian coast are in this stage. The time taken to develope from the depression stage to the cyclone stage generally is about 48 hours. If the cyclone gets sufficient distance to travel and favourable conditions, it may pick up more energy from the sea and intensify rapidly further within about 24 hrs and develop into the severe cyclone state. At this stage it is given an identifying name. In India it is identified by the year and the ultimate landfall region. For hurricanes on the Atlantic and typhoons over the Pacific, names of girls are used. Recently, names of boys are also being employed. Japanese meteorologists use numbers. In the fully developed severe cyclone, the central low pressure are is 30-50 km in diameter and is generally calm or has light winds. The pressure falls rapidly by 60-70 mb. The sky is clear or partially clouded and the air is warm and sultry. This central area is called the Eye of the cyclone. When the Eye arrives, people often get the wrong impression that the storm has passed. In about an hour after the arrival of the Eye, wind starts again blowing with renewed fury from the opposite direction and torrential rain comences. Surrounding the Eye is a circular ring of cumulus cloud towers rising upto the tropopause (16-17 km) and even beyond. The ring is generally 30-50 km wide and is the most dangerous part of the storm. The pressure gradient in the ring is the steepest in the storm system and there may be winds 200-300 kmph in the extreme cases. There is torrential rain in this region and tumultuous sea. If the cyclone landfalls in this stage there may be surge of the sea in the sector where the wind blows landward. This storm surge may be reinforced by astronomical tides causing waves which may be of the order of 10 m high. This storm surge may cause flash floods of areas to the extent of 20-30 km inland. It is this storm surge that causes 90% of deaths of people and loss of cattle. The Eye and the circular ring round it called the Eye Wall, which may extend to a circular area 100-150 km radius and both together is called the Core of the cyclone. In the outer circulation beyond the core, the pressure increases rapidly. Surrounding the cloud wall the winds spiral in the counter clockwise direction in the northern hemisphere and extend upto very large distances from the centre. The wind decreases with the distance from the centre. The strongest winds are to be found on the right half of the cyclone track because in this region the wind speed is reinforced by the movement of the cyclone itself For this reason this sector is called the dangerous half of the cyclone. Torrential rains are replaced by squally showers as one moves outwards from the centre and the sea quietens down. Generally, beyond 200-250 km from the centre the weather returns to normal. Because of the high winds in the ring around the centre, Indian meteorologists make a distinction between severe cyclones and severe cyclones with a ring of hurricane winds. Such distinction does not, however, conform to International practice. Our Committee tried unsuccessfully to persuade the IMD to conform to a simpler classification. There are various wind scales to classify cyclones. The Beufort wind scale has been used over a very long time. In USA, the Saffir-Simpson wind scale is used. Later I shall give another way to classify cyclones using satellite data which is now in general use. The Committee recommended the following classification (Table 5).

TABLE 5 : **Classification of Cyclones**

Classification	Wind speed (kmph)
Low pressure system	⩽32
Depression	32-61
Toofan	62-88
Severe Toofan	⩾88

The Committee reduced the number of categories of the storm, because, to the public, anything above Depressions spells danger. In USA, finer categorisations are used : Subtropical depression, subtropical storm, tropical depression, tropical storm, tropical cyclone, hurricanes, etc.

Vulnerability of Indian Coasts to Cyclones

It is now time to have a look at the vulnerability of various sections of the Indian coast to cyclones. Since the east coast is by far more vulnerable, I shall confine the discussion mainly to the Bay cyclones. I shall also indicate the relative vulnerability of the different coastal states of India. Table 6 gives the occurrance of cyclones/severe cyclones landfalling over the Bay coast on India and the neighbouring countries (East Sri Lanka, Bangladesh and the Arakan coast of Burmah) over a period of 104 years (1877-1980) :

TABLE 6 · **Number of landfalls of cyclones/severe cyclones on the Bay coast for 104 years (1877-1980)**

Season	Month	Andhra Pradesh	Tamil Nadu	Orissa/ West Bengal	Indian Total	Neighbours	Total
Pre-Monsoon	January	1/1	3/0	0/0	4/1	1/0	5/1
	February	0/0	0/0	0/0	0/0	0/0	0/0
	March	0/0	2/2	0/0	2/2	1/1	3/3
	April	1/0	1/0	0/0	2/0	9/6	11/6
	May	6/3	7/4	8/7	21/14	28/18	49/32
	June	4/0	0/0	24/3	28/3	12/3	40/6
	Total	12/4	13/6	32/10	57/20	51/28	108/48
Post-Monsoon	July	1/0	0/0	36/7	37/7	4/0	41/7
	August	1/0	0/0	29/4	30/4	1/0	31/4
	September	5/3	0/0	29/8	34/11	2/1	36/12
	October	27/7	6/1	20/9	53/17	21/11	74/28
	November	20/12	27/17	9/5	56/34	19/8	75/42
	December	2/0	12/7	0/0	14/7	15/5	29/12
	Total	56/22	45/25	123/33	224/80	62/25	286/105
	Total	68/26	58/31	155/43	281/100	113/53	394/153

A glance at the table shows at once that the Orissa-West Bengal coast has the highest vulnerability to cyclones, and next in sequence come Andhra Pradesh and Tamil Nadu. The table shows also that for the Orissa-West Bengal coast, the period May-November is marked by very high occurrance of cyclones. The corresponding period for Andhra Pradesh can be split into two parts : the premonsoon season May-June, and the post-monsoon season September December. For Tamil Nadu, the cyclone seasons are : pre-monsoon season January and March-May and the post-monsoon season, October-December. The picture for the Arabian sea is seen from Table 7 :

The Gujarat-Saurashtra coast is the most vulnerable on the West coast, and the cyclone seasons are April-July and September-January The Indian total for the Bay is 281/100 and for the Arabian sea, only 30/16. Thus, the Bay coast is about 9 times more vulnerable to cyclones and about 6 times more vulnerable to severe cyclones. If the totality of total number of storms is considered, then the Bay coast is about 8 times more vulnerable than the Arabian coast.

Cyclone Frequencies

It is instructive to look at the cyclone incidence over shorter periods of time. We may divide the 104 years (1877-1980) into 26 years intervals to get some indication of whether there is any change in the synoptic

TABLE 7 : **Number of landfalls of cyclones/severe cyclones on the west coast for 104 years (1877-1980)**

Season	Month	Kerala/ Karnataka	Maharash-tra	Gujarat/ Saurashtra	Indian Total	Neighbours	Total
Pre-Monsoon	January	0/0	0/0	1/0	1/0	0/0	1/0
	February	0/0	0/0	0/0	0/0	0/0	0/0
	March	0/0	0/0	0/0	0/0	0/0	0/0
	April	0/0	0/0	1/1	1/1	1/1	2/2
	May	2/2	1/1	1/0	4/3	7/6	11/9
	June	0/0	0/0	4/3	4/3	11/8	15/11
	Total	2/2	1/1	7/5	10/7	19/15	29/22
Post-Monsoon	July	0/0	0/0	2/0	2/0	0/0	2/0
	August	0/0	0/0	0/0	0/0	0/0	0/0
	September	0/0	0/0	4/1	4/1	0/0	4/1
	October	0/0	1/1	4/1	5/2	4/2	9/4
	November	2/1	4/2	3/3	9/6	1/1	10/7
	December	0/0	0/0	0/0	0/0	1/0	1/0
	Total	2/1	5/3	13/5	20/9	6/3	26/12
	Total	4/3	6/4	20/9	30/16	24/18	54/34

TABLE 8 : Cyclone generation in the east coast in 26 year period
R = Number of severe cyclones/number of cyclones

Coast	Period	Duration (years)	Number of storms	R
Andhra Pradesh	1877-1980	104	68	0 38
	1877-1902	26	14	0.21
	1903-1928	26	19	0.27
	1929-1954	26	14	0.36
	1955-1980	26	21	0.52
	1965-1980	16	14	0.71
Orissa/West Bengal	1877-1980	104	155	0.28
	1877-1902	26	46	0.24
	1903-1928	26	39	0.26
	1929-1954	26	41	0.26
	1955-1980	26	29	0.41
	1965-1980	16	21	6 48
Tamil Nadu	1877-1980	104	58	0.53
	1877-1902	26	13	0.54
	1903-1928	26	10	0.40
	1929-1954	26	19	0.47
	1955-1980	26	16	0.69
	1965-1980	16	9	0.78
East coast	1877-1980	104	281	0.35
	1877-1902	26	73	0.29
	1903-1928	26	68	6.31
	1929-1954	26	74	0.32
	1955-1980	26	66	0.52
	1965-1980	16	44	0.61

situation in this area in course of the years. We may also study the changes in the ratio R of severe cyclone in course of years. Table 8 gives the relevant data for the east coast.

There seems to be significant rise of the numbers of storms over Tamil Nadu and the Andhra Pradesh coasts, while the number on the Orissa-West Bengal coast seems to be fluctuating. There seems also to be a significant rise of the ratio R in all the three coasts, particularly in the last 16 years. Too much must not be read in this analysis. The reason for the rise may lie in the use of better methods in storm detection and diagnostic methods now available with the establishment of coastal network of observation stations, radar facilities and satellite surveillance. But there may be real synoptic changes in the Bay area leading to increased storm formation, in particular of severe storms.

Breeding Ground of Cyclones

We may now look at the breeding grounds of the Indian cyclones. I have said already that some of the Arabian sea cyclones are not generated on this sea at all, but are residuals of those born over the Bay that cross over the tip of the Indian peninsula to draw nourishment again from the Arbian sea and intensify. The statistical figures are as follows: Over the period 1877-1980, 463 cyclones and 172 severe cyclones were generated over the Bay, and 120 cyclones and 74 severe cyclones were generated over the Arabian sea. Further 26 cyclones and 16 severe cyclones crossed over from the Bay to the Arabian sea area. Some of the Bay cyclones also are residues of those formed over the China sea straying into the Bay and intensifying again in this area. It may also be observed that of the 463 cyclones and 172 severe cyclones formed over the Bay, 394 and 153 landfalled, and 69 and 19 dissi-

TABLE 9 : **Breeding ground of the Bay cyclones**

Region (coast)	Season	Location of genesis of cyclones
Andhra Pradesh	Pre-monsoon	Storms generally formed in the region 12°-16°N and 80°-85°E
	Post-monsoon	The locations are scattered over a large area of the Bay
Orissa & West Bengal	Pre-monsoon	The locations are scattered over a large area of the Bay
	Post-monsoon	The locations are scattered over the north and adjoining portions of the central portion of the Bay
	Post-monsoon	The locations are scattered over a large area of the Bay
Tamil Nadu	Pre-monsoon	Storms mostly formed in the region 10°-13°N and 80°-85°E
	Post-monsoon	Storms mostly formed in the region 7°-13°N and 80°-92°E

pated on the Bay. For the Arabian sea area, of the 120 cyclones and 74 severe cyclones, 54 and 33 landfalled and 66 and 41 dissipated on the sea. Table 9 gives a statistical view of the breeding ground on the Bay of the cyclones in this region.

Theory of Cyclone Formation

I have now finished with the statistical informations about cyclones, and I should now give some indication about the current theories of their formations. Most meteorological theories are somewhat speculative. There is, for example, no unanimously accepted theory, for such a phenomenon as monsoon on which our well-being so much depends inspite of the elaborate 1977 Monex experiment. Several models have been proposed for formation of cyclones intensification and movement. Charney's theory of conditional Instability of the second kind (CISK) causing cyclone formation is probably the best explanation of the phenomenon. The CISK process stresses the need for the interaction between the cumulus convections and large scale motion. At the lower levels the strong inflow and surface friction over the sea produces low level convergences resulting into development of cloud towers. The latent heat released by the cumulonimbus cloud towers warms the air aloft and reduces the surface pressure at the centre. This heating reduces the surface slightly consequently increasing low level convergence because of the frictional turning in the boundary layers. Further inflow and vigourous development of the cumulonimbus cloud towers and release of latent heat aloft follow, producing further lowering of central pressure. This interactive process goes on till there is equilibrium between the lapse rate in the cloud towers and the warmed up environment. Further upper air warming of the upper air and consequent pressure fall is not possible. The system now reaches a steady mature state and may start to decay. All this process is possible in a region where the vertical wind sheer through the troposphere is small enough to allow the released latent heat to concentrate in fairly small areas. Gray considers that the small vertical wind sheer is the primary factor in the development. In another model depending on convergence-divergence coupled model, the hypothesis is that for the development of the cyclonic vorticity in the lower levels convergence is necessary. To counteract the lower level convergence, upper level divergence is necessary. This probably produces anticyclonic circulations in the troposphere. When the upper divergence overcompensates the lower convergence, pressure can fall generating a low pressure area which then can start concentrating into a depression. Of the various theories the CISK theory is most attractive, but difficulties arise when attempt is made to parametrise the cumulus activity, drag coefficients and other factors necessary in the theory.

Cyclone Diagnostic Methods

For diagnostic purposes and public warning system three parameters are of highest importance—pressure fall, wind velocities and cyclone track/movement. We shall first discuss pressure fall which is the difference of the pressure at the Eye and the normal pressure in areas far away from the cyclone region where normal atmospheric pressure prevails. The correlation between the two valid for the Indian region is given by the formula, given by Mishra and Gupta

$$v_m = 14.2(p_n - p_o)^{1/2}$$

which represents the cyclones on the Indian sea. Here v_m is the maximum wind speed in

TABLE 10 : Relation between maximum wind speed (kmph) and pressure fall $p_n—p_0$ (millibar)

Existing classification	Maximum wind speed	Pressure fall
Low pressure system	≤32	≤1 43
Depression	32-50	1.43-3 61
Deep depression	51-61	3.91-5.40
Cyclone	62-88	5.73-10 95
Severe cyclone	89-117	11 43-19 68
Severe cyclone with a core of hurricane wind	≥118	≥20.31

kmph, p_n and p_0 are respectively the pressures at the periphery and the centre in millibar and is the pressure fall or pressure defect. One millibar is 0.0295 inch of mercury. Table 10 gives the correlation.

Remote sensing of cyclones : The measurement of pressure fall/maximum wind speed is difficult from land-based observatories when the cyclone is on the sea and very often there is not much time available for assessment before the landfall of the cyclone and start of its destructive role. Ship-observations are too few for a total assessment. It is therefore necessary to achieve remote detection of the cyclone while it is still far out on the sea and measure its parameters by the modern technologies that have been developed. With the 10 cm radars installed on the Indian coast, cyclones can now be detected as far out as 400 km in normal circumstances and often at much larger distances. These radars can often detect the prehurricane squall lines formed in the outer periphery of the cyclone, the outer spirals of convective bands formed in advance of the main rain-shield, the main rain-shield itself and the precipitation spiral bands, the intense Eye-wall surrounding the precipitation free eye, the detailed features of the Eye itself, the rainfall intensities in the various sectors of the cyclone field and the track and movement of the cyclone. With the coming of geosynchronous satellites, it is now possible to keep a continuous surveillance of the cyclone, study completely its three-dimensional structure, assess in detail the various parameters and record its track and movement.

Dvorak's classification of cyclones : The important part of the Radar/Satellite detection technique is the detailed observation of the Eye from which it is possible to put cyclones on a scale of development as the earthquakes are put on the Richter scale which gives an idea of its intensity. The classification system followed for cyclones all over the world stems from the work of Dvorak, who worked out the classification system from a careful study of the Satellite pictures of cloud features of the cyclones on the Atlantic and the Pacific, and results of probing of these cyclones by aircrafts carrying meteorological instruments. From certain features of the cyclone a BF (outer banding feature) number is first assigned. This is defined by the width and curvature of the cloud band round the central feature. The Eye is next examined together with the cloud features about it (central dense overcast shape, size, boundary, texture, etc.) and a CF (central feature) number is assigned. These two numbers are then summed to give the T number (tropical classification number of the cyclone) which is directly related to the pressure fall. T1 and T2 denote the early stages of development, whereas numbers above T6 denote that the storm has reached the superstorm stage. The change of the T number is watched continuously to determine whether the storm is intensifying or whether is weakening. Dvorak uses another CI (current intensity number) which is directly correlated to the maximum wind speed. The CI number differs from the T number to account for features not directly connected to the cloud features on which the T number depends. Two factors that affect the CI number are the observed delay in the reduction of the maximum wind speed after the cloud features indicate that the storm is weakening and the cresting of the wind between satellite observations. The correlation between the T number and the CI number depends on the evolutionary history of the cyclone. The CI number is related to the T number by certain relations, i.e., the CI number is increased, left unchanged or decreased by a certain prescription according to the state of evolution of the cyclone. This prescription is based on a model of storm-development set up by Dvorak which categorises the development as rapid/typical/slow, depending on the rate of change of the T number and also how much the development of the storm deviates from his model. The correlation the CI number with maximum wind speed/pressure fall is not the same for the Atlantic and the Pacific oceans and would presumably be different for the Indian region. Mishra and Gupta have made a correlation for the Indian region which is given in Table 11. But this correlation needs

TABLE 11 : Correlation of the CI number with the Maximum Wind Speed (MWS)/pressure fall (PF) in the Indian region

Type	CI number	MWS (kmph)	PF (mb)
Deep Depression	2.0	56	4.5
Cyclone	2.5	65	6.1
	3.0	83	10.1
Severe Cyclone	3.5	102	15.0
Severe Cyclone with	4 0	120	20.9
a core of Hurricane wind	4.5	143	29.4
	5.0	167	40.2
	5.5	189	51.6
	6.0	213	65.6
	6.5	235	80.0
	7.0	259	97.2
	7.5	287	112.1
	8.0	315	143.3

to be verified by direct probing of Indian cyclones by instrumented aircraft and for different rate of development of the cyclone.

Instrumented aircraft for probing cyclones: In 1948, an American transport aircraft unintentionally wandered into an Atlantic hurricane and passed through it unscathed after experiencing severe turbulance. Since then it was found that flying through cyclones are quite safe. Probing of cyclones by instrumented aircrafts is now a highly developed art. In USA hurricanes over the Atlantic and typhoons over the Pacific are routinely probed by these aircrafts as part of the National Hurricane Operation Plan of that country. Intricate patterns of traversing the storm at various levels above the sea surface upto heights as much as 30,000 ft and as low as 1500 ft above sea level have been developed for studying various aspects of cyclones. The objectives of the probings are: (1) Reconnaisance data about the position of the aircraft, following the prescribed flight patterns at the specified flight levels, (2) Meteorological data near the sea level and other flight levels—Storm centre position, total/free air temperature, vertical temperature profile, sea surface temperature, wind direction/speed at pilot head/flight level, atmospheric pressure at flight level/vertical pressure profile, dew point, humidity at flight level/vertical humidity profile, cloud liquid content, total liquid content in the air and spectrum of hydrometeor sizes. The instruments carried aboard these aircrafts are generally weather radar, plan position indicator radar and down-looking belly radar, normal meteorological instruments for measurements at the flight levels, dropsonde instruments for obtaining the vertical profiles of various parameters of various meteorological parameters, onboard photographic systems and data acquisition systems, recording and processing computers, and communication systems with the ground station. These probings give a complete three-dimensional structure of the cyclones and are a great help in predicting the evolution of the storm and for devising methods of remote estimation of the maximum wind speeds and pressure falls as is the system of Dvorak, for example. Our Committee recommended that such a method should be applied to the Indian cyclones. The Committee has recommended the purchase of such a cyclone probing aircraft, but apart from very high cost of such an equipped aircraft there are also logistic problems of flying and maintenance. Even if such an aircraft cannot be purchased, the objective may be achieved by giving the task on time bound contract to those agencies who have the necessary expertise. Alternatively, it may be possible to persuade organization like the World Meteorological Organization to sponsor a project for this purpose as was done for the Monex Experiment.

Instruments aboard Satellites: The satellite surveillance has become very important as has already been stated. The most important instruments on the satellite are very high resolution Radiometer (VHRR) working in the visual and the Infrared part of the spectrum to image the cloud cover and its structure. The ground resolution for the visual channel is 2.5 km and for the infrared is 11 km. Satellite surveillance views the storm from the top and gives informations about various details of the clouds in the storm system—cloud coverage/top altitude/changes of pattern/movement/temperature, and temperature gradients in the system. The satellite system also keeps continuous record of the movement of the Eye if it is a geosynchronous satellite. Infrared imaging makes it possible to view the storm at night when the visual channel is inoperative. The satellites also carry data collection transponder for relaying to the ground station the meteorological/hydrological/oceanographic data collected by automated autotelecasting Data Collection Platforms installed in inaccessible areas on land and sea. Coastal radars view the storm from the side and its detection range is limited. In both systems of surveillance, the Dvorak classification of storm is generally used.

Forecasting Cyclone Tracks and Movements

To the people living on the coast, the most important information desired about a cyclone is where it will landfall. Cyclones can often be most erratic in their movements. They may move steadily in a certain well-defined direction, or stand stationary at a certain location contemplating what to do next, or suddenly change its course in a totally unexpected direction even looping round and retracing its original course. Satellites do help to keep the storm under constant surveillance but is able to give very little indication about its future movements. There have developed over the years a number of modelling techniequs to give some forecast about future motions and I shall give a list without going into too much details. The track forecasting methods can be grouped into two broad classes : Empirical techniques that make no use of the regression equation and those that use it or use some other basis. Empirical techniques are subclassed in three groups. The first is the persistence technique which is based on the last 12-24 hrs motion and depends on the assumption that the causes and forces that cause the movement continue to be effective. This technique is often reinforced by climatology information about the average temporal/spatial repeatativeness of the tropical storms. In the Empirical group falls also the synoptic technique which depends on simultaneous observation of pressure, temperature, moisture and wind of the cyclone field gathered either by ground/ship/satellite observations. The Synoptic technique has been in use for a long time. In this model the surface geotropic steering is determined by the pressure gradient and also by the gradient of the Coriolis force if the storm is located at low latitudes. Interactions with westerlies or the easterlies are also important. Sometimes, upper wind steering by winds around the cyclone field at 300 or 200 mb levels may also be important. Techniques which are not empirical can be put into two subclasses : Statistical techniques which include the Analog models and also those that use the regression equation. The Analog model is based on the assumption that the current cyclone track can be identified with a parent track belonging to a family of historic tracks in the region and that inferences can be drawn from what happened in the past. In India, this method has been in use for a long time. The Analog method has been made more effective with the use of the Regression equation to generate the Stimulated Analog technique which uses some of the cyclone predictors in a functional sense. In this method, the 7 basic predictors used are : the Julian day number, initial latitude/longitude, average meridional speed in the last 12 hrs, average zonal speed in the last 24 hrs and if available, the wind speed or the central pressure. The models depending on the Regression equation, specifically the statistical or the dynamical models, a part of the variance reduction potential is derived from the predictors which is the output of some numerical prediction model and a part derived from climatology. The dynamical methods are based upon setting up of a numerical model initialised from the observed data and the time-dependent hydrodynamic equation integrated upto the forecast time. In practice, many difficulties limit the effectiveness. For those storms that behave erratically, statistical methods generally fail and greater use of the equation of motion is needed. The simplest dynamical model is the barotropic model using wind observations averaged from the data from 1000-100 mb levels and then their nondivergent part is obtained by relaxing for the stream function within the centre of the grid and the storm centre is identified by the local minimum stream function whose track is then computed. In USA this method has been in use since 1970 and is known by the acronym SANBAR. A variety of this technique—the Balanced Barotropic Model is used in Japan. Another variety—the Primitive Equation Model is used in USA for prediction centres for typhoons over the Pacific. Due to the large grid size used, the errors of forecasting are large—283 km for 24 hr prediction, 461 km for 48 hrs and 702 km for 72 hrs. The first really objective forecasting system using the Regression Equation for 24 hrs prediction was developed by Riehl *et al.* in 1950. The method is based on the principle that the tropical cyclone moved in proportion to the speed of the vertical integrated flow surrounding the vortex. In various varieties of this technique predictors selected from various levels are used. Very often, combinations of the various techniques are used to get the best predictions. The best method is still the data on track and movement obtained by constant monitoring by geosynchronous satellite. Study of satellite pictures often give some clue to the future motion of a cyclone. It is often observed that cloudiness extends in advance of the direction of motion of a cyclone and its major structural features tend to retain the same relative location with respect to the direction of motion. This helps to identify the direction of motion. Hourly observations of the eye via geosynchronous satellites give the track speed. The IMD has prepared an Atlas of all tracks of major cyclones in the Indian region during the last 100 years. This is not yet available to the public, though our Committee has recommended a cheap edition of this.

Storm Surges

Another important matter which is of major concern to the people living on the coast is the storm surge which may accompany a cyclone i.e., the rush of the sea over the coast inundating large areas of the coastal land. The storm surge is the most devastative part of the cyclone drama and as I have already stated is responsible for about 90% of the deaths besides destroying vast amount of crops and large number of mud houses. Attempts have been made to construct models for forecasting sea surges for Indian cyclones by scientists of the IMD among whom the contribution of Dr. P. K. Das and his group are very important. The basic equations represent the propagation of long waves in shallow waters. The storm itself is assumed to be an idealised one moving with constant speed and is assumed to have concentric isobars and an inner ring of winds but no crossbaric flow. For the surge, the assumptions are that the surge amplitude is small and the horizontal scale of the surge large compared to the sea depth. Interaction between the surge and the astronomic tide is also provided for in the model. The objective was to relate the surge at the time of the landfall with the speed of propagation of the storm in terms of storm parameters derived by satellite observations. The model was applied to the storm surge caused be the 1970 November Bhola cyclone hitting Bangladesh and the adjoining countries on the Bay. The conclusions were that: (1) For the northern and north-eastern sectors of the Bay highest surges are associated landfalls in Bangladesh, (2) The contributions on the peak surge by the storm speed was small compared to that by the pressure fall, (3) The maximum surge was generally observed about 2 hrs after landfall occurring 30 km to the right of the Eye, (4) The total sea level elevation depended on the peak of the tidal cycle, the maximum elevation occurring earlier if the surge coincided with high tide, and (5) Superposition of the surge on the astronomic tide led to an overestimate of the sea level elevation by 0.8 to 1.1 metre. A detailed study has been made by F. J. Wood of the correlation of the historic devastating storm surges with the positions of the Sun and the Moon which cause astronomic tides and the effects of the phenomena of Seiche, i.e., stationary waves and amphidromic movements caused by Coriolis force. I do not know whether such studies have been made for the Bay coast as well. Wood has also studied the Perigean spring tides when the bodies Sun-Moon-Earth are in the sygygy configuration, i.e., in one line and the Moon is at the perigee of its orbit. These spring tides are generally of greater magnitude than the usual tides. Wood has also studied the Proxigean spring tides which cause particularly devastative tides. Here the configuration is the same for the Perigean situation but the Earth is also at the perigee of its orbit. Of course, the alignments are generally strictly not as stated but are close enough. Wood was calculated 14 Perigean configurations between 1979-1999 AD, some of which bear the dates ; Jan. 28, 1979 ; Oct. 23, 1980 ; Dec. 10, 1981 ; Feb. 17, 1984; Nov. 12, 1985 ; Dec. 30, 1986 ; Oct 14, 1989; and extreme Proxigean configuration on Dec. 2, 1980 ; Jan. 19, 1992 ; Mar. 8, 1993. I have not the time to find out how many of these predictions have come true. Since storm surges must have a storm to initiate it, I shall give a list of the historic storm surges when I present you a list of some historic rogue cyclones.

The Cyclone Review Committee

It is now time to say some thing about the Cyclone Review Committee (CRC). Earlier the Cyclone Distress Mitigation Committee (CDMC) under the Chairmanship of Dr. P. Koteswaran had made many valuable recommendations some of which were implemented in the different coastal states and proved to be effective upto a point. Then came the 1977 Nov. Chirala cyclone killing about 8000 persons necessiating another review of the whole problem which led to the formation of the Cyclone Review Committee.

RECOMMENDATIONS OF THE CYCLONE REVIEW COMMITTEE :

The terms of reference of the CRC was :

(1) To review the existing storm warning systems in the country—assessment of the requirements of additional facilities and aids as used in different countries, for improving the forecasting facilities.

(2) To review the telecommunication facilities existing in the country and suggest improvement and modernisation thereof and additional telecommunication facilities and widening the dissemination of information.

(3) To review the present status of the community preparedness to anticipate cyclones and their impacts and to review the action plans for cyclone distress mitigation and to recommend measures for improvement in these respects where necessary.

(4) To review the cyclone codes in operation in other countries.

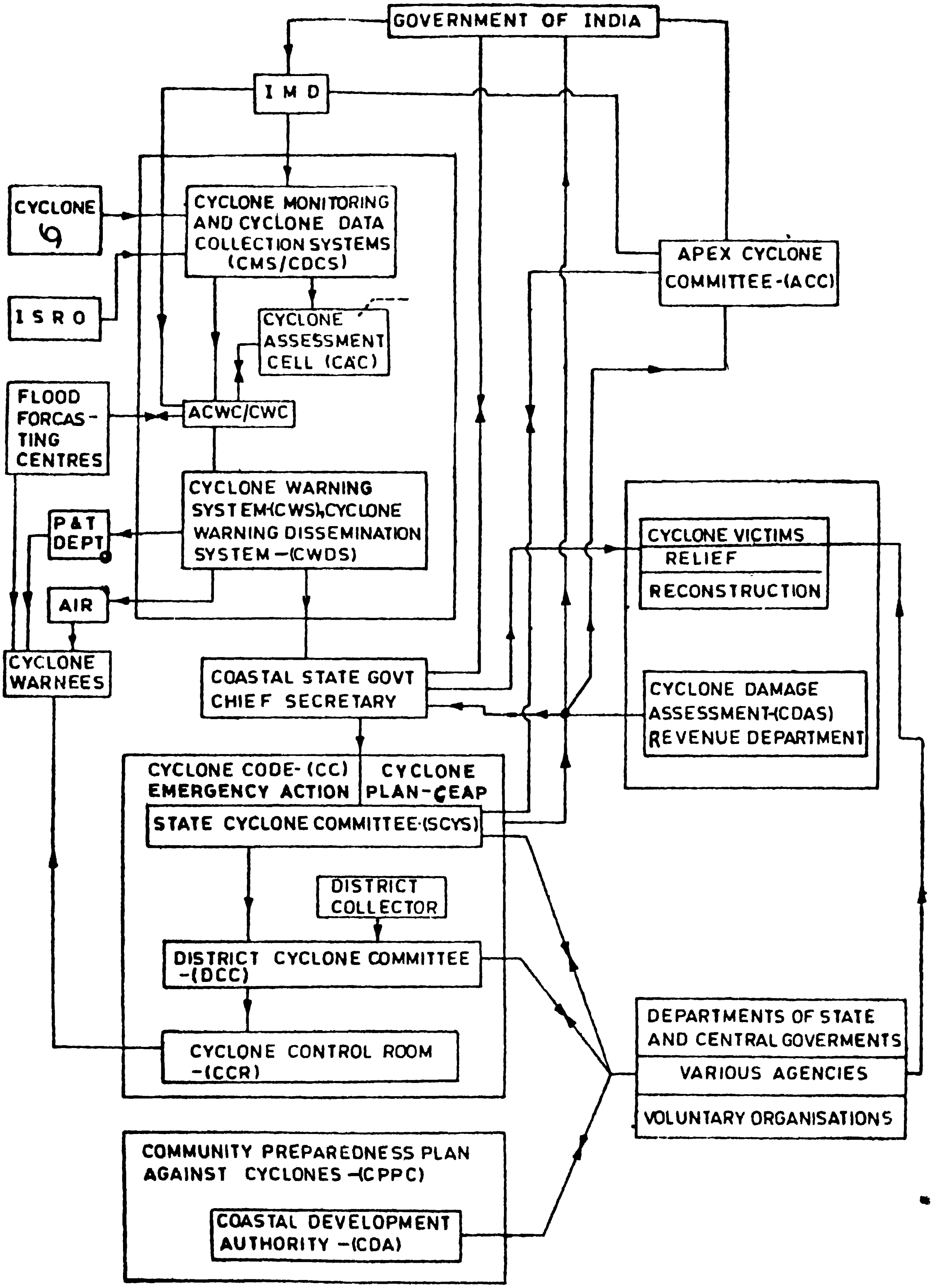
GOVERNMENT OF INDIA
I M D
CYCLONE
ISRO
CYCLONE MONITORING AND CYCLONE DATA COLLECTION SYSTEMS (CMS/CDCS)
CYCLONE ASSESSMENT CELL (CAC)
APEX CYCLONE COMMITTEE-(ACC)
FLOOD FORCASTING CENTRES
ACWC/CWC
CYCLONE WARNING SYSTEM(CWS),CYCLONE WARNING DISSEMINATION SYSTEM-(CWDS)
P&T DEPT
AIR
CYCLONE WARNEES
CYCLONE VICTIMS
RELIEF
RECONSTRUCTION
COASTAL STATE GOVT CHIEF SECRETARY
CYCLONE DAMAGE ASSESSMENT-(CDAS) REVENUE DEPARTMENT
CYCLONE CODE-(CC) EMERGENCY ACTION
CYCLONE PLAN-CEAP
STATE CYCLONE COMMITTEE-(SCYS)
DISTRICT COLLECTOR
DISTRICT CYCLONE COMMITTEE -(DCC)
CYCLONE CONTROL ROOM -(CCR)
DEPARTMENTS OF STATE AND CENTRAL GOVERMENTS
VARIOUS AGENCIES
VOLUNTARY ORGANISATIONS
COMMUNITY PREPAREDNESS PLAN AGAINST CYCLONES-(CPPC)
COASTAL DEVELOPMENT AUTHORITY-(CDA)

Fig. 1. The Cyclone Plan (CPL) for India

(5) To advise the Government with a comprehensive cyclone code to meet any situation caused by cyclones.

The Committee submitted to the Government a complete Cyclone Plan (Fig. 1) and a large number of recommendations in three groups.

The first group was mainly for the IMD with respect to the cyclone monitoring/warning systems regarding :

(1) Organisations for the formulation implementation and review of the Cyclone Plan.

(2) Demarcation of the Cyclone prone areas of coastal India and consideration of terrains and seasons.

(3) Cyclone detection observation and tracking methods and facilities in India.

(4) The Cyclone warning system in India.

The second group was mainly for the Government of India and the coastal State Governments with respect to a proposed National Cyclone Code and the Cyclone Emergency Action Plan and formulation of a Community Preparedness Plan. In this, there was elaborate recommendations for action at different stages of a Cyclone emergency and for warning/rescue/relief/rehabilitation of the victims and restitution of damaged properties. The last group covered recommendations for research and training.

The Cyclone Plan : The Cyclone Plan suggested by the committee consisted of :

(1) Setting up of a Apex Cyclone Committee under the Ministry of Agriculture and Rural Development to review from time to time the effectiveness of the various plans and to coordinate the various organisations and agencies involved. The Agriculture Ministry is traditionally responsible for dealing with various types of similar disasters.

(2) Modernisation of methods of cyclone monitoring and diagnostics and warning systems by the IMD which is responsible for these activities.

(3) Setting up of State Cyclone Committees and the District Cyclone Committees which would be responsible for local warning/rescue/relief / rehabilitation of the victims/restitution of damages to properties i.e. to operate the Emergency Action Plan and for post cyclone actions by the State Governments.

(4) Setting up Coastal Development Authority which would be responsible for long term constructions—Cyclone Shelters, coastal road network, cyclone proof telecommunication system, systems to limit storm surges ; coastal afforestation ; implementation of land zoning laws ; establishing of cyclone emergency stores at stategic points on the coast and many other things.

I do not have the time for reviewing the entire Cyclone Plan. I shall only review the monitoring systems which has been greatly strengthened in recent years reducing greatly the cyclone threat as now much earlier warning can in principle be given, I shall give an idea from a number of specific cases to show how the system works in actual practice. About the rest of the plan the Committee has stressed that the programme for meeting the problems created by cyclones and the plan for preparing the community would have many things in common with the plans for facing the hazards associated with other natural disasters like droughts/floods etc. and that each state should work out their specific disaster plans. Among all the coastal states Tamilnadu has taken a holistic view of natural disasters and has worked out a complete disaster plan for itself. Tamilnadu and Andhra Pradesh have done commendable work for preparing their coastal communities for cyclones. Unfortunately though West Bengal is the most cyclone prone state in India the State Government has done very little in this respect. The problem in West Bengal is aggravated by the existence of numerous islands in the river delta to which it is difficult to send the warning.

Cyclone Detection/Monitoring/Warning Systems in India

To people living on the coast the important thing is to have a sufficiently early warning to be able to take adequate precautions for saving lives and properties. It is interesting to recall that the cyclone warning system was started in 1885, ten years earlier than the Indian Meteorological Department. In course of time an elaborate coastal chain of observation stations have been reinforced by the latest technological development. An account of these facilities is given below :

I. *Observatories for measurements of the weather near coastal region* :

(1) The surface observatories—these have been established to measure humidity, wind, clouds and rainfall ; the wind measuring instruments in these stations are grossly inadequate for cyclones.

(2) The Cooperative Cyclone Reporting Network—this was established in the extremely cyclone prone areas on the recommendation of the CDMC after the 1977 Chirala cyclone. The observatories are of the surface observatory type worked by part time workers but are more closely grouped and are confined to the states Andhra Pradesh, Orissa and West Bengal ; in practice part time workers have not been found very useful.

(3) Upper Air Observatories equipped with pilot Baloons for tracking wind by visual sighting, Radio wind instruments and also arrangements for Radiosonde method of data collection through radio channels.

(4) Data Collection Platforms (DCPs) are being installed in remote inaccessible areas on land and sea to collect meteorological/hydrological/oceanographic data.

(5) Tidegauges—These need considerable improvement to be really effective in giving the necessary data about storm surges.

Recently oceanographic research vessels have been acquired to extend the field of observation over high sea and recording of sea condition to get information about sea-air interaction.

II. *Techniques for Remote Sensing of Cyclone established in India* :

(1) Cyclone Detection Radars : A radar horizon extending to about 400 km out from the land covering the entire Bay coast and partly the Arabian Sea coast has been established by installing a number of Cyclone Detection Radars (CDR) ; during the 1977 Chirala Cyclone the nonexistence of the Masulipatnam CDR proved to be very expensive in terms of loss of human life. This lacuna was later removed. The images from the radars could be used to classify a cyclone far out in the sea by employing Dvorak's technique and also to observe the movement and track.

(2) Recently the geosynchronous satellite INSAT-1B has been put into orbit which is equipped with very High Resolution Radiometer in various spectral ranges in the visual and the infrared. This satellite can keep a cyclone in the Indian region under constant surveillance and give informations from the cloud pictures at various levels about its classification on the Dvorak Scale and about its movements right from its genesis to its termination.

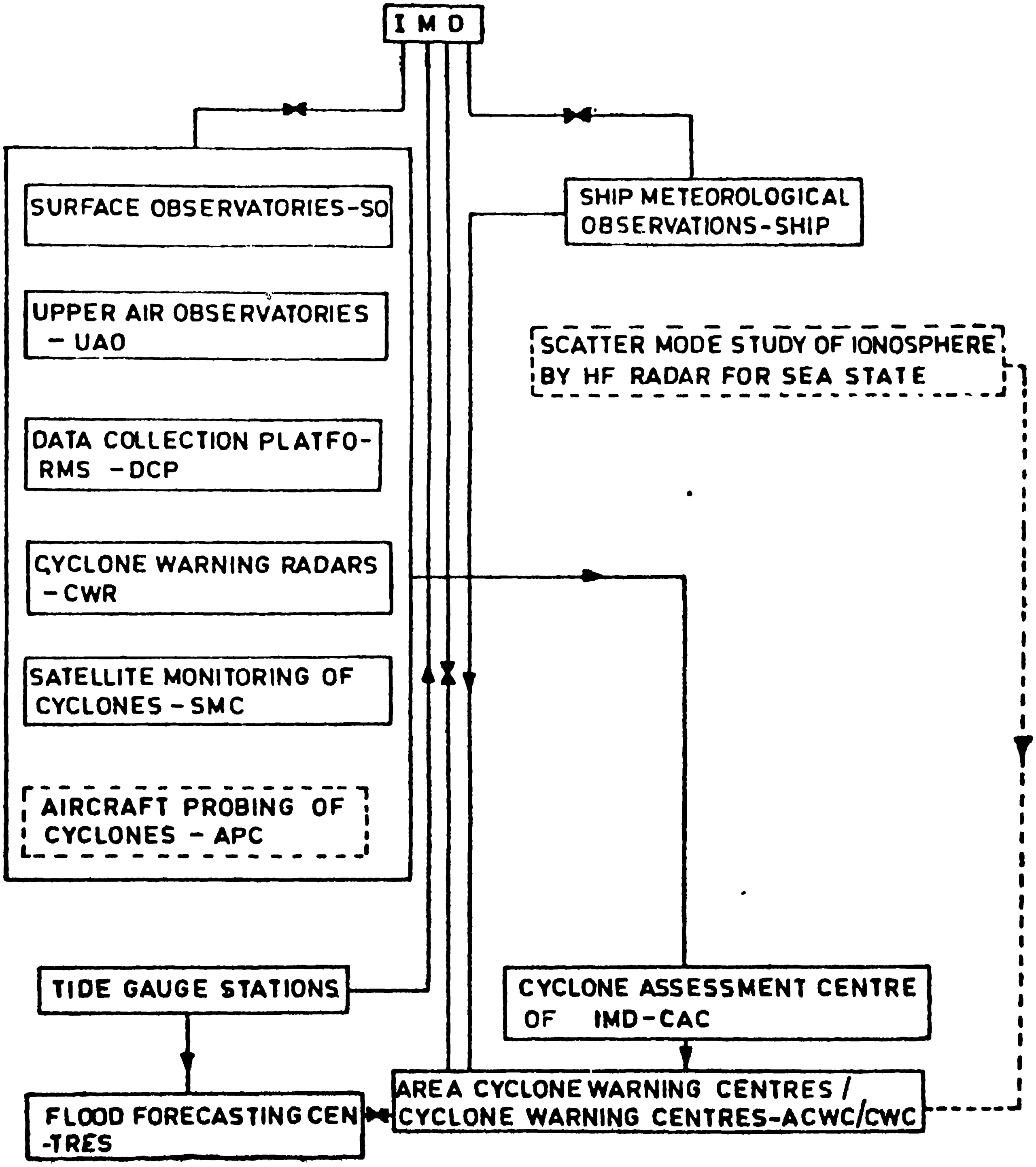
I M D
SURFACE OBSERVATORIES-SO
UPPER AIR OBSERVATORIES - UAO
DATA COLLECTION PLATFORMS -DCP
CYCLONE WARNING RADARS -CWR
SATELLITE MONITORING OF CYCLONES - SMC
AIRCRAFT PROBING OF CYCLONES - APC
SHIP METEOROLOGICAL OBSERVATIONS-SHIP
SCATTER MODE STUDY OF IONOSPHERE BY HF RADAR FOR SEA STATE
TIDE GAUGE STATIONS
CYCLONE ASSESSMENT CENTRE OF IMD-CAC
FLOOD FORECASTING CENTRES
AREA CYCLONE WARNING CENTRES / CYCLONE WARNING CENTRES-ACWC/CWC

Fig. 2. The Cyclone Monitoring System (CMS) in India

(3) The Committee has recommended the purchase of at least one instrumented aircraft for cyclone probing as a normal routine. As already mentioned this would give very detailed informations about the three dimensional structure of cyclones and also provide data to calibrate Dvorak's classification with respect to the Indian region. Fig. 2 summarises the locations of the cyclone monitoring stations in the different coastal states in India.

It is easy to be impressed by the number of land based observatories for cyclone monitoring set up over the Indian coast. But in my opinion that while these are important for normal meteorological work, they are generally of very limited use for cyclones when they are far out on the sea for the measurements made at the land based observatories are of the parameters only on the periphery of the cyclone on the land. We have seen that the data near the Eye are imperative for a proper assessment of the cyclone. For cyclones remote sensing CDRs and geosynchronous satellite are certainly sine quo non.

Cyclone Warning Facilities in India : The cyclone warning system received special attention from the CDMC and also from the CRC on the recommendation of the CDMC Area Cyclone Warning Centres (ACWC) were established at Bombay, Calcutta and Madras. Two other smaller Cyclone Warning Centres (CWC) were established in Bhubaneshwar and Visakhapatnam. These centres are responsible for issuing area bulletins, coastal weather advisories, port warnings, fisheries warnings, cyclone bulletins, cyclone warning messages, general directives advisories and informatory messages to all those who require the warnings and informations including the people living on the coast, or sailing in ships and boats on seas and concerned officials.

After INSAT-1B was put in orbit Meteorological Data Utilisation Centre was established at Delhi to receive and process the weather data transmitted by the satellite and send them on to the ACWCs and the CWCs. Taking advantage of INSAT-1B a Disaster Warning System (DWS) is proposed by which the warnings and messages from the ACWC/CWCs would be transmitted to the state officials concerned via the satellite and received by them with special receivers. This system is expected to avoid the hazards faced by normal telecommunication system which are likely to snap during cyclones.

The ports have their own system of warning signals which are hoisted during storms. The ports are generally of 4 types so far as the warnings are concerned—those that extend the system of II signals used generally by the other ports except those that use only 5 out of the normal II signals. For the minor ports the warnings are received but the warning signals are not hoisted. Thus the ports can be classed as :

(1) E—Using the extended signals,
(2) G—Those that use the normal signals,
(3) B—Those that use the brief system and
(4) S—The small ports that only receive the warnings.

The Post and Telegraph Department maintains coastal radio stations for issuing weather bulletins to ships and coastal vessels. It has other coastal radio stations for Broadcasting of coastal bulletins. The Indian Navy has its own Wireless station to warn its ships. The coastal population receives the cyclone warnings mainly through the All India Radio. The AIR also has special stations to broadcast warnings to fishermen on sea. Recently the television network in the coastal states have been greatly extended and can be an important component in the Cyclone warning system.

Fortunately for India after the CDMC made its recommendations heavy loss of life caused by cyclones has not happened, Bangladesh and the Arakan coast of Burma have not been so fortunate. This may be because the cyclones landfalling in India in this period may not have been of sufficient magnitude or that the warning system had worked satisfactorily for some reason. In the ultimate analysis the warning system depends on the very elaborate telecommunication system that India has : landbased telegrams telephones, UHF, Cable and Microwave links all of which may snap in a cyclone scenario. When the INSAT-IB based disaster warning system is set up then it is expected that the communication system will be completely immune to cyclone hazards. In a mock test in a non-cyclonic situation it was found that the humble post card defeated the most modern communication technologies. I shall later describe failures of the existing communication systems in some selected cyclonic situations.

Historic Cyclones

I shall now give you a selection of some of the devastative cyclones of the past. I shall first give you a rather short list of those that happened outside the Indian peninsula (Table 12).

TABLE 12 : Some famous historic cyclonic storms outside the Indian peninsula

1099 AD	*England.* Dead 300000
1250 AD	*Venice.* The city was submerged
1287 AD	*Holland.* The sea wall collapsed and Zuider Sea flooded over the land. Dead 100000
1570 AD	*Holland*
1635 AD	*Plimoth foundation*
1723 AD	*Boston*
1825 AD	*Holland*
1846 AD	*Boston.* (1) 1st March 3 days after the perigean situation with new moon. (2) 7th-8th September 1 day after the maximum perigean situation with full moon. (3) 3rd October closer perigean situation
1885 AD	*New York and New Jersey*
1894 AD	*Holland*
1900 AD	*Galvaston* Texas.
08.09.1900 AD	*Galvaston* Texas. Aperigean situation. Perhaps the greatest loss of life caused by hurricane and accompanying storm surge. Dead 6000
1914 AD	*Los Angeles*
1916 AD	*Holland*
1928 AD	*West Indies.* Dead in West Indies 2600. Dead in West Florida also 2500
04 03. 1931 AD	*From New Jersey to Nova Scotia.* Extreme proxigean situation
1953 AD	*Holland and England.* Dead in Holland 2000 and in England 300
22-24.12.1954 AD	Twin storms in *North Sea* within 36 hrs of each other which is the period of oscillation of this sea
1966 AD	*Italy.* Sirocco (hit wind from Sahara) struck North Italy. Venice flooded and almost destroyed. Two high tides followed each other in night and morning. Surge 1.98 m above the normal high tide
1978 AD	*Boston.*

I shall now introduce you to some of the rogue cyclones that have visited the Indian subcontinent. Table 13 gives a selection of these cyclones.

TABLE 13 : A selection of some famous historic cyclones which visited the Indian subcontinent

Date	1. *Technical details* : (a) Landfall point, (b) Landfall date and time, (c) Maximum wind speed (kmph), (d) Minimum pressure (mb), (e) Track speed (kmph), (f) Height of storm surge (m), (g) Rainfall 2. Devastation 3. Remarks
1737 AD	*Calcutta.* Great devastation. Dead 300000.
05-10. 1864 AD	*West Bengal.* I. (a) near Contai, (b) Oct. 5 early morning, (f) storm surge arrived at the mouth of R. Hooghly a little after 10 PM reaching maximum height at noon, the low lying areas neighbouring the river upto Akra in Midnapore and lower reaches of R. Roopnarayan upto Kolaghat inundated. 2. Dead 50000 from flood and 25000-30000 from epidemic.
.10.1864 AD	*Masulipatnam* Andhra Pradesh. 1. (a) Masulipatnam. 2. Dead 40000.
24.11-01.12 1876 AD	*Backergunge* Bangladesh. 1. (a) mouth of R. Meghna, (b) Dec. 1, 3-3.30 PM, (d) 935 mb, (e) 4 kmph-24 kmph at the final stage near land, (f) Height varied from 3.05-12.19 m. The storm surge was reinforced by astronomical spring tide. Water receded at 8 AM. 2. Dead 100000 from storm and surge and another 100000 from epidemic. Inundation all over the low lying areas and the islands in the region. 3. The height of the surge is probably the highest ever recorded in the subcontinent.
19-23. 09.1885 AD	*Orissa.* 1. (a) *False Point,* (b) 22nd 6 AM, (c) 243 kmph, (d) 919 mb probably the largest pressure fall ever recorded in the subcontinent, (e) 21 kmph, (f) storm surge arrived at 8 AM, surge height at False Point harbour 6.7 m and at Jambo 6.4 m, large scale flooding round the harbour. 2. Inundation over low lying areas and all houses destroyed.
25-26 05.1941 AD	*Bangladesh.* 1. (a) 22.5°N90.50°E between *Barishal* and *Noakhali,* (b) 26th morning, (c) 160 kmph, (f) storm surge inundated Bhola to a depth of 1.52-3.05 m, water level in the low lying areas round Bhola 3 05-3.66 m.
15-16. 10.1942 AD	*West Bengal.* 1. 21.35°N87.25°E near *Contai,* (b) 6th afternoon, (c) 226 kmph, (f) on 26th large areas north and south of Midnapore and 24 Parganas inundated, devastation by bore 774 sq km in south Midnapore, water level was upto 3.06 m along the coast between longitudes 87°-89°E. 2. Dead 75000, cattle lost 6000, villages destroyed 1600 on area 1859 sq km, population affected 7.5 lakhs. 3. Wind speed probably the maximum ever recorded in India.
26-27. 10.1949 AD	*Andhra Pradesh.* 1. (a) 16.05°N81.05°E about 10 km south of *Naraspuram* near Masulipatnam, (b) 28th at 0130 hr, (c) 130 kmph with gusts upto 185 kmph, (d) 965 mb, (e) 11 kmph, (f) 3 05-4.57 m high storm surge inundated eastern and

(Cont.)

TABLE 13 *(Cont.)*

	western coastal districts of Godavari between latitudes 16°-17°N upto a distance of 6.44-8.04 km inland. 2. Dead 750, cattle lost 30000, houses destroyed 0.25 million, crops destroyed over 0.405 million hectare. 3. This was a cyclone with a core of hurricane winds.
09.12. 1973 AD	*Bangladesh.* 1. (a) Near *Barishal.* Strong gale swept Namkhana and Pathar Pratim in West Bengal, (f) In Khulna district in Bangladesh storm surge was 4.5 m high. 2. Motor vessel Sonavali sank in the Bay 256 km south-east of Vishakhapatnam. In India considerable damage to standing and just harvested crop in coastal districts of Contai, Ramnagar, Digha and Junepat. In Bangladesh considerable damage in Patuakhali, Barisal and Khulna districts.
08-11. 09.1976 AD	*West Bengal.* 1. (a) East of *Contai* at 21.55°N 87.55°E, (b) 1100 hr, (c) 160 kmph gust and steady wind 148 kmph recorded at Sagar Island, (c) 972 mb, (d) 17 kmph, (f) 2-3 m high storm surge inundated areas between longitudes 87.30°-89°N in 24 Parganas and Midnapore. 2. Dead 10, loss of cattle 4000. 3. This is a peculiar cyclone as it affected far away places in Bihar and Uttar Pradesh.
24-29 11.1976 AD	*Tamil Nadu.* 1. (g) unprecedented rainfall in Madras 42.5 cm in 24 hrs in Madras and Chingleput districts. Total rainfall 1482 cm which is 75% above normal. 2. Ramnathapuram and Rajasinghamangala tanks breeched causing heavy inflow in Vagui submerging several villages.
08-12.11.1977 AD	*Tamil Nadu.* 1. (a) Near Nagapattinam, (b) 12th early morning, (c) 143 kmph, (d) 965 mb
14-20.11.1977 AD	*Andhra Pradesh* 1. (a) North of Chirala 60 km west of Ongole, (b) 19th 1730 hr, (c) 259 kmph, (d) 941 mb, (f) 5 m high storm surge swept the Elettidibba Island on the estuary of R. Krishna and the main coast of Masulipatnam ; the storm surge went 12 km inland ; very heavy rainfall in coastal Andhra Pradesh and Telengana, (g) a very well monitored cyclone watched by satellite, cyclone warning radar and ships on the Bay ; a classical case of failure of the cyclone warning system inspite of large amount of accurate informations gathered through different systems. 2. Dead : 8547, cattle/other animals lost : 5,74,244, population affected : 71 lakhs, cropped area affected : 14.6 hectare, houses destroyed/damaged : 10,10,336, damage to public utilities : Rs. 11 crores.
17-28.11.1978 AD	*Tamil Nadu.* 1. (a) Between Kilkarai and Rochi Mary Nagar, (b) 24th evening, (c) 222 kmph, (f) 3.5 m high storm surge affected Rameswram Island and Ramanathpuram district between Tondi and Devipattinam. 2. Huts destroyed : 5000, loss of property : Rs. 5 crore.
05-13. 05.1979 AD	*Andhra Pradesh.* 1. Between Nellore and Kavali, (b) 12th (c) 189 kmph, (d) 954 mb, (e) 18 kmph, (f) 3.05 storm surge inundated areas round Buckingham canal. 2. Population affected : 40 lakhs, Dead : 700, cattle lost : 3 lakhs, property loss : Rs. 170 crores, cropped area affected : 0.28 lakh hectare.
01-04. 06.1982 AD	*Orissa.* 1. (b) 4th 0900 hr, (c) 180 kmph, (g) the cyclone was detected by INSAT-1A earlier than by the CWR at Paradwip. Another notable case of failure of the cyclone warning system because of lack of interdepartmental cooperation. 2. Extensive damage to Paradwip port.

CASE HISTORY OF SOME FAMOUS CYCLONES

I shall now make case studies of some famous rogue cyclone in order that some appreciation can be obtained of the difficult nature of the problems that can appear. I have selected two cyclones over Bangladesh and two over India. The first two landfalled at about the same region on the coast near Bhola. For one of them, the earlier one, I shall give some idea of how cyclones appeared to sailors about 100 years ago and for the other, I shall give an idea of the enormous deaths that a cyclone can cause even in the present time. The Indian cyclones selected demonstrate the way the most well planned cyclone warning systems may fail as a result of the misjudgements of the human decision makers.

The 1876 Backergunge Cyclone: The chronology of the cyclone is given below :

(1) The cyclone was apparently formed on Oct. 25-27 in the region to the west of Andamans in Lat. 10°N Long. 89°E and it moved northwards gradually recurving to north-west ;

(2) The eye of the cyclone moved from 10°N 89°E on noon of Oct. 27th to 22° 30′N 91°E on afternoon of Nov. 1st. The average velocity of movement of the cyclone increased from 4 kmph on noon of Oct. 27th to 24 kmph on afternoon of Nov. 1st.

(3) A large number of ships were plying in the area and were severely affected. These took most important data regarding the cyclone. An extract from the log book of one of these ships would give some idea of the ferocity of this cyclone : Extract from the log book of ship Palmas reads as follows : "Left Negapatam on the 12th October bound for Calcutta, and was near the Eastern Channel lightship on the 30th. At midnight the barometer began to fall rapidly, and the weather looked very threatening and all preparations were made for a strong gale. At noon on the 31st it was blowing a hard gale. By this time it must be an approaching cyclone. The ship was evidently in the north-west quarter of a cyclone, travelling from south-south/west to north-north/east. At 2 PM the heavy sea and lurches (assisted by the quantity of water gone below) caused the sand ballast to shift to starboard, giving the ship a heavy list to leeward. With the heavy lurching the 90 fathoms of starboard chain broke adrift and was thrown on the lee gunwale and at the same time all the sails and provisions etc. on the weather side of the fore cabin were thrown leeward, throwing the ship almost on her beam ends. We slacked away fore and main topsail sheets to try to right her, the fore one blowing away in the act and had to slack off the main topsail sheets till it blew away. We squared the main and cross-jack yard and put the helm up to try to put her on the other tack to get the low side up and although we were already on the right tack for the cyclone, but the ship would not pay off but continued to come up as the wind was hauling more northernly and causing the heavy south-south/west sea to break in over our lee rails and poop and endanger the safety of the ship by knocking against the hatches. When in this position cut away topgallant backstays, the masts going over with their geer and fouling the topsail yards. We could not cut them clear, as all the wires got twisted and turned together. At 4 PM the cyclone was increasing;

barometer 28.5″, the sand still shifting to leeward and putting the ship on her beam ends. I saw that the next thing to cutting the masts away would be to let go the starboard anchor, and let it run 90 fathoms chain from the lee side. I went forward with the Chief Officer and saw all clear and let it go, taking the 90 fathoms chain with it. The ship then righted a great deal, and less sea came over the rails. We then had a chance to go below to trim some of the ballast and I sent all hands below for that purpose, leaving the carpenter, sailmaker and one man on the deck to look out for the hatches and tarpaulines. In the meantime the top-gallant masts and yards were swinging about and cutting the top sails and courses adrift from the gaskets and causing them to be blown away. At 6 PM when the barometer stood at 28.2″. we had the heaviest blow. The centre of the cyclone was then passing about 40 miles to the eastward, the wind hauling to the north-north/west and north-west with vivid flashes of lightning thunder and rain. At this time the whole of the remains of our sails were blown away, the top-gallant yard had this time got down, and on alongside and knocked against the side and chaffed very much, but could not cut it clear. At 7 PM the gale abating, we ceased trimming, the men being all tired and worn out and the south-south/west sea being then nearly aft, ship heading up north-east by north and rolling much less. 3 PM gale moderating and the barometer having risen to 28.5″, let all hands go to rest and get ready for the next day's work, to clear the wreck and trim ballast. Midnight the weather clearing and wind moderating."

Out of the humdrum sea jargon of the Captain's log book a picture of the high drama of a cyclone emerges as evocative as any thing written by Conrad. We should now follow the most destructive part of the career of the cyclone, its landfall. A remarkable feature of the cyclone was the very great increase of its track velocity on approaching the coast of Bangladesh. The report given in the Hand-book of cyclonic storms in the Bay of Bengal records the final stage of the tragedy : "The most remarkable feature of the Backergunge cyclone was the enormous storm wave which it drove over the islands and low lands at and near the mouth of the Meghna. The inundation was due to an unusually high tidal wave, followed very shortly afterwards by the storm wave. It was full moon on the evening of the 31st and there was hence a spring tide, which flooded the low-lying land at the head of the Bay. High water was due at Chittagong at 0-30 AM and in the mouth of Meghna from 1 AM to 2 AM. The pressure of the advancing storm wave prevented the tidal and river water flowing off. The storm wave hence retarded over the shallow water near the entrance to the Meghna and accumulated there and finally over-powered the down-flowing waters, and rushed with irresistable force over the islands and low lying coast districts, covering them to the depth of from 10 to 30 on 40 feet in the course of a very short space of time, probably less that half an hour. The water receded very quickly as the storm passed inland and began to break up and at 8 AM they had entirely retreated, after having destroyed all the crops and drowned a very large proportion of the inhabitants. The first estimate of the

> destruction of life was given as 200,000. A later and probably more correct account puts the loss of life by drowning at 100,000 and the loss subsequently by disease (chiefly Cholera), directly due to the inundation as 100,000 It is therefore probably not too much to say that the storm wave caused directly or indirectly the death of nearly a quarter million of people."

As I have stated this cyclone probably holds a record so far as the height if the associated storm surge is concerned

The 1970 November Bhola cyclone: This followed a very similar track as this cyclone and the landfall points were also very close to each other. About the same number 200,000 people died in the 1970 cyclone

The 1977 Chiralla Cyclone: The 1977 cyclone in Andhra Pradesh in November has secured for itself a position in the annals of tropical cyclones not only because of its tremendous devastation and death role but also because it exposed the many ways by which the assessment techniques, the warning systems and the emergency measures failed leaving the State Government in a state of paralysis. The cyclone started as a low pressure system moving westward across Malayasia and the Andaman sea on 14th November. From the very first stages beginning with 14th till the instant of landfall the cyclone was under constant satellite surveillance. The US satellite was in polar orbit and therefore information was available only twice daily. Till 15th the cyclone moved westwards intensifying. On 16th and 17th the satellite pictures gave clear indications that the cyclone had changed course to a more northerly direction and that the strom could be classified as T7 on the Dvorak scale suggesting a wind speed of 260 kmph (Fig. 3). The ship Jagatswamini made detailed observations as it passed through the eye of the storm and collected observations from other ships in the neighbourhood and communicated the data to ACWC Madras and received congratulatory messages. The cyclone came in the range of the CDR—Madras for the first time at 1000 hr on the 17th and was subsequently tracked by it till it landfalled. The cyclone was under constant observation by the cyclone detection radar at Madras throughout its lifetime but for some reason ACWC—Madras downgraded the danger potential on 19th at 0905 hrs. The CDR at Masulipatnam was not in existance at that time and no cross check was available on another radar closer to the cyclone system. However the USA satellite gave a complete picture of the cyclone till the instant of landfall. The Madras radar predicted from the study of the cyclone track between 15th and 16th that the landfall point would be somewhere between Guntur district and Vishakhapatnam. The warning issued as late as 0915 hrs on 19th reflected this thinking On 17th the cyclone had changed its course to a more westerly direction as was clearly observed by the satellite but this data was ignored by ACWC—Madras. Finally at 1200 hrs on 19th ACWC—Madras woke upto the real situation and predicted that the cyclone would landfall between Ongole and Masulipatnam. The estimates of the storm surge was grossly underestimated. At 1730 hrs on 19th the cyclone landfall occurred north of Chirala near Nizampatnam The eye passed 60 km east of Ongole and 50 km west of Masulipatnam. There was only 5 hrs and 30 mins to put the emergency measures into operations —in fact the whole State Government was completely paralised till 21st. There was wide spread rainfall in Guntur Krishna east and west Godavari districts and adjoining portions

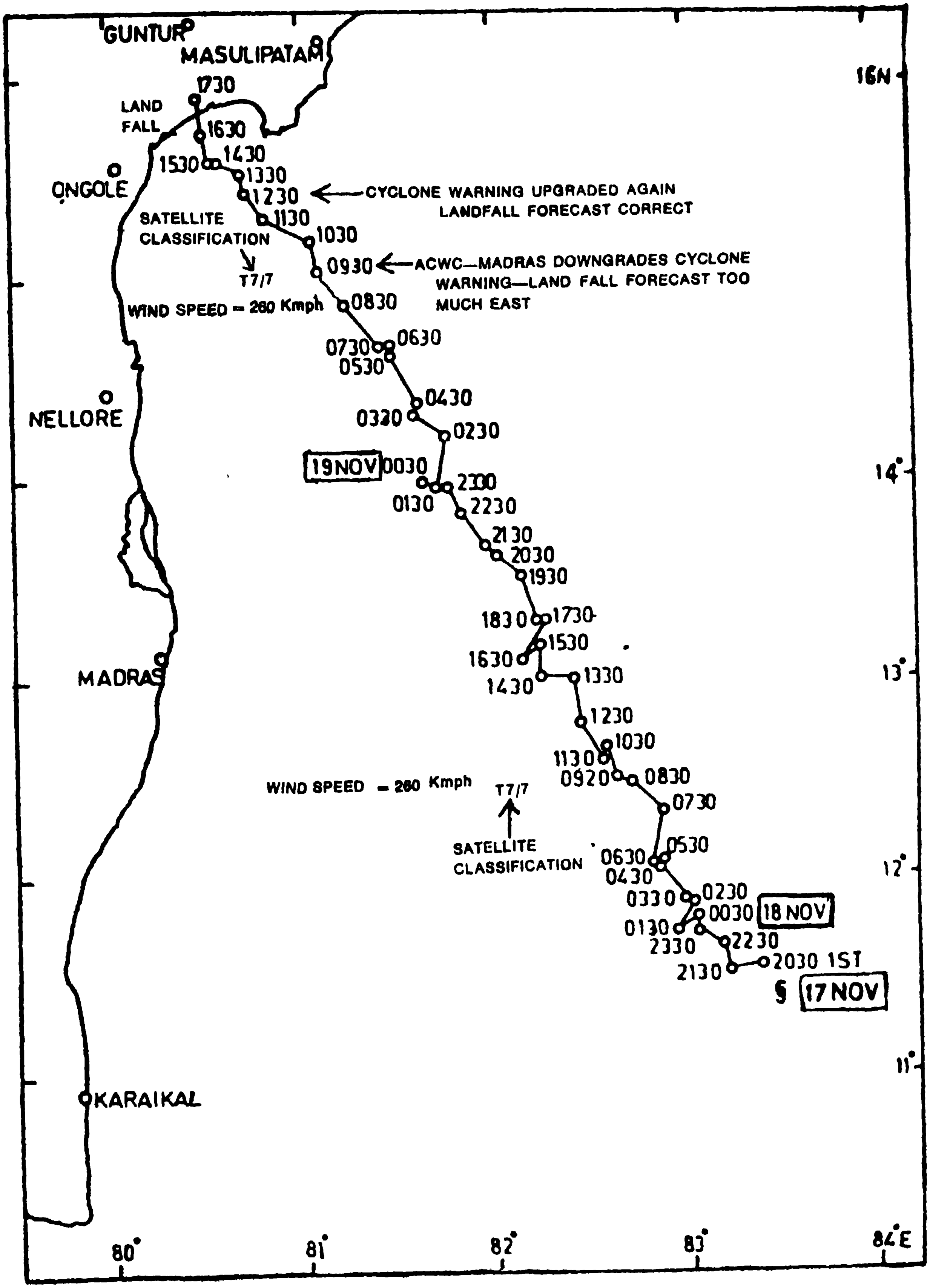

Fig. 3. 1977 November Chiralla Cyclone : Radar Track November 17 to landfall

of Vishakhapatnam and Khammam districts (Fig. 4). The stormsurge was 5 m as against the predicted 1.5 m. The surge extended to 12 km inland and a bore went up River Krishna upto Rapalle taluk. The area submerged was Divi Edurmondi and Eletidebba islands in the Krishna estuary (Fig. 5). The fury of the storm can be gauged from the fact the steel columns of the Vijayawada power station were sheared off. About 20 villages in Divi taluk and 8 villages in Konar area in Bandar taluk in the Krishna district was washed away laying to waste 500 sq km of the country side.

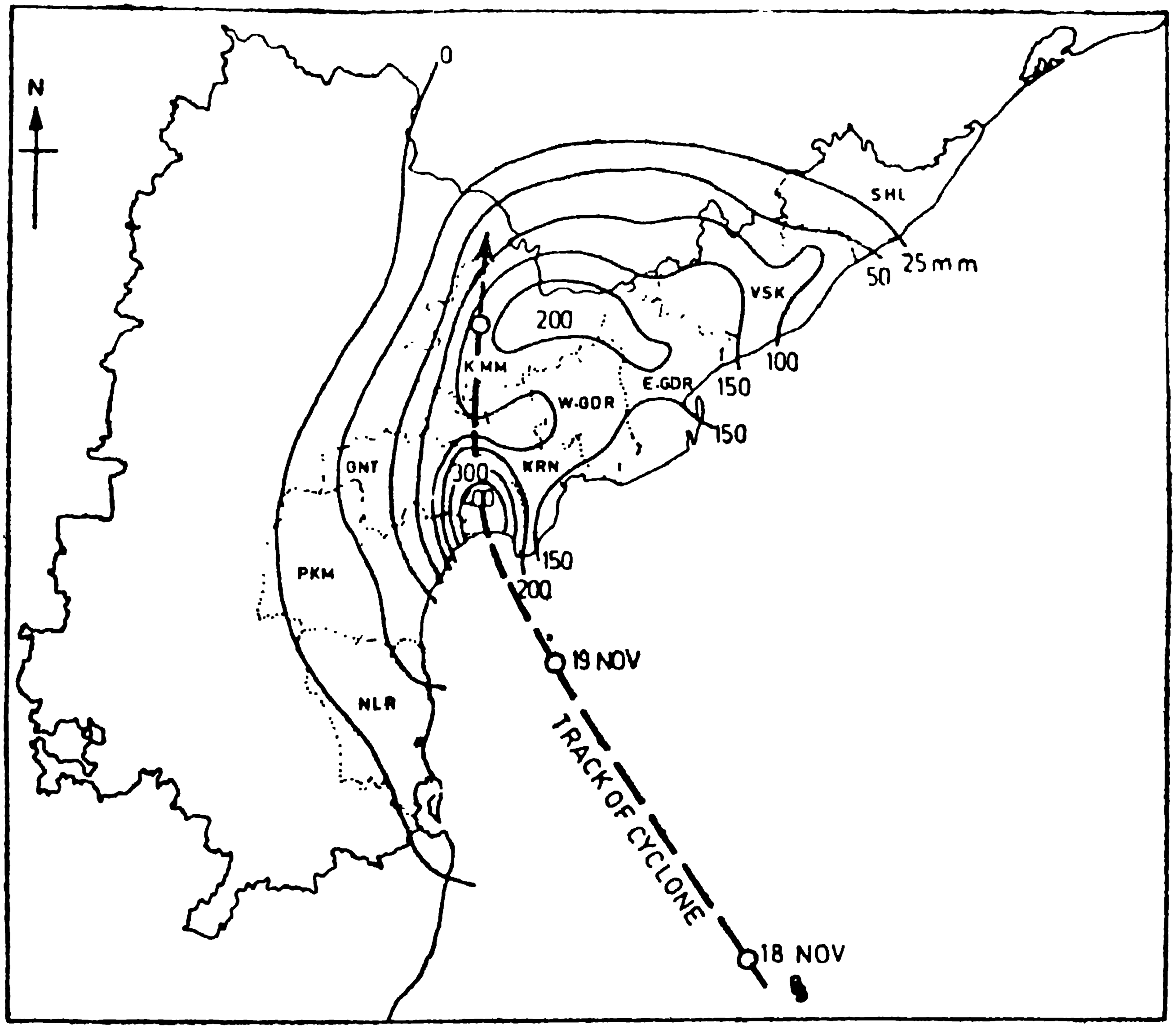

Fig. 4. 1977 November Chiralla Cyclone : Rainfall for 24 hr ending at 0830 hr IST on November 20

The loss and damage were finally assessed as follows :

Population Affected (in lakhs)	=	71
Cropped Area Affected	=	36.04
Houses Damaged/Destroyed	=	10,10,335
Human Lives Lost	=	8504
Cattle Heads Lost	=	2,30,146
Goats & other Livestock Lost	=	3,44,058
Damage to Public Utilities (Rs. in Crores)	=	176.66

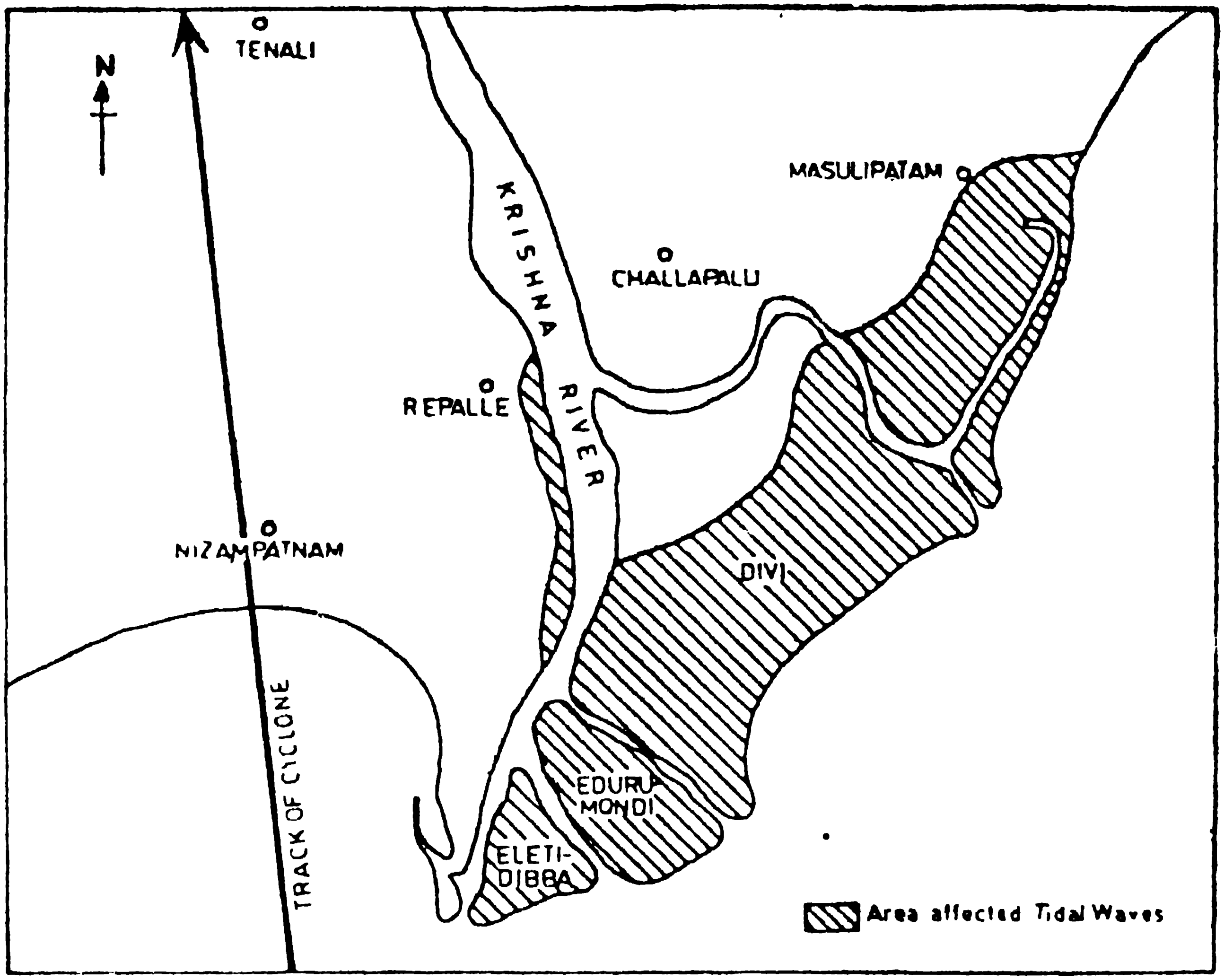

Fig. 5. 1977 November Chiralla Cyclone : Extent of surge innundation

Here was a cyclone which was under observation throughout its lifetime and all its parameters were well measured. Yet there was a lapse on the part of those responsible for interpreting the available data and issuing a correct warning in time for the authorities in time causing a major tragedy. Perhaps the reason for this failure was that at that time the satellites looking at the cyclone were of the polar type and therefore the informations were available only twice daily. This limitation has now been removed with the installation of the Geosynchronous INSAT satellite.

The 1982 Orissa Cyclone (*1st-4th June*): ? I mention this not because of any special feature of its devastativeness but here after the implementation of the Cyclone Distress Mitigation Committee's recommendations we see a glaring example of the failure of the Cyclone Warning System. The cyclone was detected by INSAT-1A earlier than the CDR—Paradip. The cyclone warnings were sent right on the first day (1st June) when the storm was 500 km from the coast. However the Paradip PO did not treat them with the priority assigned to them. All communication links between CDR—Paradip, CWC—Bhubaneswar and the control room at the Central Secretariate at Bhubaneswar broke down by 3rd June. The Cooperative Cyclone Reporting Network which included the police WT system did not work and which was set up, on recommendation of the CDMC also did not work. The only means of communication was AIR Cuttack, Sambalpore and Delhi which however did not report the sudden intensification of the storm 8-9 hrs before landfall on 3rd June when the wind intensified from 85 kmph to 180 kmph. This sudden unusual intensification was not detected by either INSAT-1A or by CDR—Paradip. The most unfortunate part of what happened was that Port Signal Office at Paradip which was within a few hundred meters of CDR—Paradip was not completely briefed as a result of which it was completely unprepared for the storm when it arrived at the port.

Present Status of Cyclone Problem

To bring this lecture to a conclusion the following things may be stated. The phenomenon of cyclone is not fully understood and any predictions about it—its intensification process, its parameters, its track and evolution, tend to be speculative at best. But there exist now high technology in this country of detecting it right from the moment of its genesis on high seas and follow it to the landfall point and observe its complete life history and continuously watch the changes of its parameters. It is often possible from study of the sattellite picture to classify it and predict the track and the landfall point. It is not difficult today to give a 48 hrs warning in favourable circumstances that is if the cyclone does not suddenly change course. As to the rest of the programme—conveying the warnings to the likely victims, evacuating them to safe places and specially constructed shelters, rescuing the marooned victims, bringing relief and rehabilitating them, these form a part of the General Disaster Plan of the concerned State. This plan needs to be improved and strengthened for the general experience is that there is not conspicuous success in putting these plans into operation when the emergency comes. We have made many recommendations about such a Cyclone plan and I believe that it is possible to prevent loss of human life and cattle though of course it is not possible to limit the loss and destruction of property and crop. The Cyclone Preparedness Plan which we have suggested recommends construction of Cyclone Shelters, constructions to limit storm surges, designs of houses which can stand up to the furg of cyclone and many other things. It is to be hoped that the some action would be taken by the Government of India and the coastal State Governments to implement the Cyclone Plan. □

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THE NOR'WESTER AS A NATURAL HAZARD

P. K. DAS*

The article reviews the present status of Nor'westers in the context of the coming International Decade for Natural Disaster Reduction (IDNDR). They form a sudden on-set type of hazard in the category of wind storms. The present prediction techniques and their limitations are discussed for an early warning system. An intense research and observation programme is described with a high resolution grid. This could form a useful contribution to IDNDR. Finally, the article discusses several disaster reduction measures. Particular emphasis is placed on the wind field, and an estimate of maximum wind speeds by numerical models.

Introduction

Nor'westers are high frequency severe storms, of small dimension, that occur over the north-eastern parts of India in the pre-monsoon months. The strong winds associated with them are known to cause much damage and devastation.

As a natural hazard they come under the category of intense atmospheric vortices, such as, tornadoes and thunderstorms. Unlike other natural hazards, such as, droughts, the Nor'wester has a very small onset period. It sets in with a sudden and explosive violence. Consequently, the time available for early warning, or initiating damage prevention measures is small.

Natural hazards do not recognise political boundaries. A global view of the dangers posed by natural hazards is now beginning to emerge. The realisation that a concerted drive by many nations, by international or regional cooperation, is needed was one of the lessons learnt from the recent earthquake that hit Armenia in 1988.

International cooperation

Recognising the need for global action, the General Assembly of the United Nations passed a resolution in 1987 to declare the 1990s as an International Decade for Natural Disaster Reduction (IDNDR). In general terms, the principal theme of this resolution was "to create a hazard-resilient world". The resolution owes a great deal to the initiative of Professor Frank Press of the United States.

Following the adoption of this resolution an Expert Committee was set up with Professor Press as its Chairman. This Committee has had a few meetings in the past one year while trying to make the coming IDNDR a success. Several other Agencies of the U.N. system have now become interested. The International Council of Scientific Unions (ICSU), for example, set up an ad-hoc group of experts which met in Rabat last year. The meeting drew up a list of natural hazards and considered ways of increasing public awareness of natural hazards for the coming International Decade for Natural Disaster Reduction.

A list of natural hazards is of necessity fairly long, but all members of the scientific community have included tornadoes and

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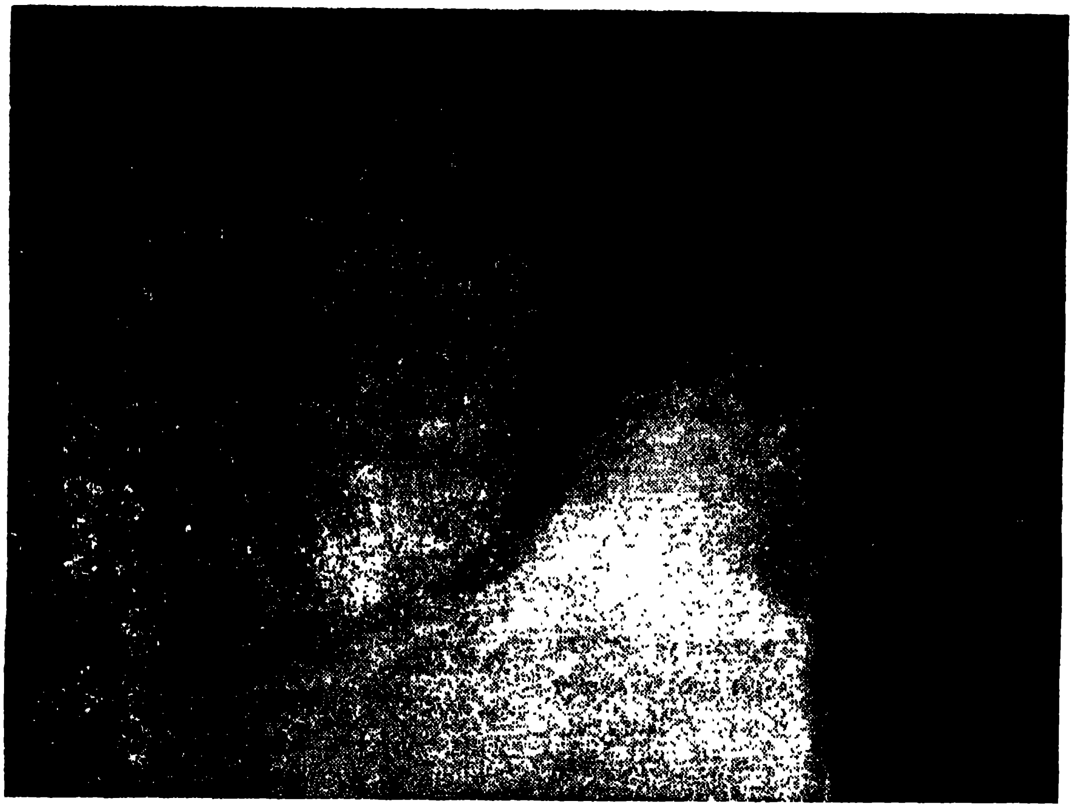

A tornado near Oklahoma (USA) on May 22, 1981
[From "Confronting Natural Disasters", National Academy Press, Washington, D. C., 1987]

A collapsed bridge on Sandeep Island in Bangladesh on May 1985 due to violent winds
[From "Confronting Natural Disasters", National Academy Press, Washington, D. C., 1987]

thunderstorms in their list. They form a subset of windstorms because the maximum damage is caused by strong winds. An estimate suggests that during the period 1900-1987 over 680,000 deaths have occurred in different parts of the world on account of windstorms alone. It is in this context that we must view Nor'westers, especially because the 1990s—the years of the International Decade for Natural Disaster Reduction—are not far away.

The structure and genesis of a Nor'wester

The sudden onset and violence of a Nor'wester, coupled with its short life time and small dimension, has made it difficult to collect quantitative data on its formation. The advent of meteorological radars has improved the situation a little but a good deal still remains to be done. Doppler radars have not been used so far. Experiments with two radars used in conjunction would also seem to be worthwhile for determining the three dimensional airflow in a Nor'wester. Emphasis, we feel, should be placed on an accurate determination of the wind field because, as we can see, most of the damage is caused by strong winds.

In most theoretical work it is assumed that the Nor'wester is a vertical vortex, but observations indicate that there is an appreciable inclination to the vertical. The tilt is determined by the wind field in which the vortex is embedded. Here is another reason why measurements of the wind field are important. But, notwithstanding the need for more wind data, it must be recognised that the acquisition of data raises many logistic problems. As the size of the vortex is small and the location of its formation is uncertain one would ideally need a network of mobile radars, preferably Doppler radars.

In view of the difficulties in acquiring real time data on Nor'westers and vortices of similar size, numerical simulation experiments have an important role in research. Numerical models help us to understand the dynamical constraints on the motion of a vortex.

Nor'westers generally occur along a line of discontinuity that is often referred to as the 'dry line' of northern India. The depth of the moist current is about 1 km, while westerly, drier air prevails aloft. The discontinuity in temperature between the moist layer current below and the warmer air above is often clearly seen in vertical probes of the atmosphere by a balloon-borne instrumented package. This is a radiosonde

It is generally believed that the interface between two air masses, which have different profiles of temperature and moisture, becomes unstable when the temperature and moisture differences across the interface exceed a threshold value. Coupled with the wind shear across the interface, we have from the theory of fluid motion different criteria for different types instability. For the type of motion with which we are concerned the criterion for instability may be expressed in terms of a non-dimensional number. This is the Richardson number (R_i), which is named after the British mathematical physicist L. F. Richardson[8]. The Richardson number is defined by

$$R_i = g/T(\gamma - \gamma_d) \div \left(\frac{\partial U}{\partial Z}\right)^2 \qquad \text{(i)}$$

where γ, γ_d stand for the observed vertical temperature gradient (γ) and its value for dry air ascending adiabatically (γ_d). U is the zonal wind and g is the gravitational acceleration, while Z stands for the vertical height.

The principle on which Richardson based his work was a criterion for the onset of turbulence in a fluid that was originally in laminar motion. The non-dimensional number given by (l) is a measure of the ratio of two forces: (a) the consumption of kinetic energy by a parcel of air that is rising because it is warmer than its environment and (b) the kinetic energy that is generated by the vertical shear in the mean air flow (U). The condition for the air to become turbulent is then (b) should exceed (a) or $R_i < 1$. Originally, Richardson considered the threshold value of R_i to be unity, but subsequent improvements in theory usually yield critical values of R_i to be about 0.25.

The Richardson number has often been used as a guide to forecasting the occurrence of a Nor'wester. But, because the real atmosphere is a good deal more complex than the simple model that has been outlined, no threshold value of R_i has been discerned. In general, forecasters look for small values of R_i or large vertical temperature gradients (γ).

If we ignore the wind shear, then it can be shown that a rising parcel of air will become unstable on its own if its temperature gradient exceeds the dry adiabatic value of 10°C/km. In fact, instability of this kind may be achieved with much smaller lapse rates for moist air. As a moist parcel of air ascends it sheds its excess moisture after reaching saturation, and the condensation of water vapour is accompanied by the release of latent heat. This warms the rising parcel and provides it with an added buoyancy. Consequently, the lapse rate needed to trigger instability in moist air is nearly half the corresponding value for dry air.

A large number of theories have been developed on atmospheric instability in recent years. They have been briefly reviewed by Das[1] and Garner[2]. In the Indian context, very little quantitative data are available on the structure of Nor'westers. In common with most convective cells the basic ingredients of a mature Nor'wester cell are:

(i) a region of strong updraft and inflow of air on the front side of a cell moving to the right, and

(ii) the transport of rain out of the updraft and into a downdraft and outflow on the other side or the rear of the cell.

The air forming the downdraft is cooled by the evaporation of falling raindrops. On many occasions, the downdraft or outflow begins to progress towards the inflow region and begins to circle it in a counter clockwise direction round the updraft. This tends to occlude the low level updraft, and eventually leads to the collapse of the thunderstorm cell.

This Cellular structure is a very serious aviation hazard. Imagine, for example, an aircraft that encounters a thunderstorm cell during its landing phase. On encountering the updraft, the aviator will tend to increase his power to prevent the aircraft from being carried aloft But, when he enters the downdraft part of the cell the horizontal spread of the downdraft aided by the increased power in his engines would make the aircraft overshoot the runway. This situation is the cause of many accidents in commercial aviation.

Several numerical models can now simulate the growth of a thunderstorm cell over a "dry" line as is observed over north-east India. But, differences in model output arise when moisture is introduced. The release of latent heat, as we mentioned earlier, determines the amount of buoyancy that a rising parcel will acquire; consequently, unless we can parameterize the phase transformations of moisture correctly the model outputs may lead to different inferences.

On some occasions a number of Nor'wester cells have been observed. They tend to branch out from a single cell. The exact mechanism which leads to the formation of multiple vortices is not yet clearly understood.

A feature of considerable interest is the modification of the general wind flow by topography. In addition to the two broad wind strems that we have mentioned earlier, namely, a westerly wind from the central and northern parts of the country and a moist southerly wind from the Bay of Bengal, there is another wind flow from the north-east along the Brahmaputra valley. The modification of an existing temperature and wind discontinuity by a valley wind from the north-east is not yet clearly understood.

Early warning systems

In the Indian context, Nor'wester prediction in an operational mode is still based on observations of temperature lapse rates and vertical wind shears. As we have seen earlier they can be combined into a Richardson number (R_i). These features of the atmosphere are measured twice or four times a day depending on the prevailing meteorological system. The morning observations (00 GMT) are used to anticipate the chances of Nor'wester development in the afternoon. The success achieved so far has been variable.

As Nor'westers generally occur in the afternoon the forecaster has about 12 hours lead time. This is inadequate. And, much of his difficulties arise out of data paucity and uncertainties in the theory of Nor'wester formation.

A limited intense research and observational program could, therefore, be of considerable benefit to forecasters in the Nor'wester regions of north-east India. This could include the Himalayan foothills of north-eastern India and areas to the south and south-west of West Bengal, especially Bihar to the west and Orissa to the south-west. The duration of the experiment could be limited to the pre-monsoon months of March, April, May and the first half of June.

Observations from a high resolution grid could be organised during the period of this experiment. The typical horizontal dimensions of the phenomena that we wish to capture are given in table 1. They are collectively referred to as meso-scale phenomena by meteorologists.

TABLE 1: Horizontal Scales

Motion	Scale (km)
Dust devils	10^{-3}
Gusts	$10^{-3} \sim 10^{-1}$
Tornadoes	10^{-1}
Thunderclouds	1
Squall lines	$10 \sim 10^{2}$

Clearly it would not be possible to achieve a resolution of the order of 1 km, but if a resolution of about 50 km could be achieved, for a limited period of 3 to 4 months, one could improve our understanding of how Nor'westers develop. This could lead to an improvement in our early warning system.

The high resolution network of surface observations would require mobile radars at a few locations. Doppler radars or two radars used in conjunction would provide a three-dimensional picture of the wind field.

Another instrument that could be used with advantage is a fast response raingauge. By analysing the time series of rainfall one could infer the temporal structure of updrafts and downdrafts. Such raingauges are now being manufactured in our country, and their use for Nor'wester research should be feasible.

A limited experiment of this nature would make a substantial contribution from our country to the International Decade for Natural Disaster Reduction, because the establishment of early warning systems is one of the main objectives of the resolution adopted by the United Nations in 1987.

Disaster reduction measures

The need for disaster reduction measures was probably best highlighted by an intense storm that moved across western Europe between October 15-17 in 1987. It was reported to be one of the strongest storms for over a century[4]. Very strong winds disrupted electrical power and transport across southern England. The sea level pressure in London dropped to 960 mb, which was the lowest on record. The tragedy was that the occurrence of the storm was not forecast. Similar catastrophes have occurred in the Nor'wester prone regions of eastern India.

In an interesting article Rind *et al.*[4] report that within a period of three days from the mid-October storm of 1987, the share prices of several business houses in the United States recorded a sharp fall. Although this cannot come under the category of a natural hazard, they do point to the fact both meteorologists and economists have still some way to go before they are able to anticipate extreme events.

In this situation the choice before us is either to let the present state of affairs continue because the prediction of a sudden onset disaster is not a determinate process, or to strive towards better prediction. The latter is by far the better choice, but one must try and see that we progress at a faster rate. For this purpose several steps are needed as matters of high priority. In broad terms they are :

(i) Improve communications to hasten the speed of data acquisition, at least from a few strategic locations ;

(ii) Better risk assessment strategies ; given a set of meteorological data, to assess the risk of Nor'wester formation in terms of probability ;

(iii) Provide better public awareness service through dissemination of warnings at frequent intervals ;

(iv) Enforce a building code for construction of buildings that are capable of withstanding high winds ;

(v) Prepare a data-base for the return period of maximum winds and other climate extremes ;

(vi) Examine common features between mitigation strategies for different types of natural hazards.

One could, of course, add to the above list. But, the important point that needs emphasis is that if we are to mitigate the distress caused by violent thunderstorms, such as, Nor'westers, we need more fundamental studies to determine the mechanisms that produce them.

For this purpose a fundamental requirement is an estimate of the wind speed. In particular, we need an estimate of the extreme wind speed and the risks that are associated with such speeds. This information is needed for a cost-benefit analysis of the protective measures that are required.

Reliable records of winds over long periods of time are seldom available. Such records as do exist are very often incomplete due to damage to the instruments during the storm. On a few occasions the radar could be used to determine the isopleths of maximum wind and the propagation speed of a Nor'wester cell. If we have some statistical information on these regions, then the wind structure of a Nor'wester cell could be recreated by a numerical model. The model could be used to estimate the extreme wind speed and direction, and even to indicate the likely extent of damage.

Monte Carlo methods are being tried in some countries to generate families of storms that are compatible with the available statistics on the wind field. Further work is needed to compare the predicted wind speed with the observations.

As emphasised earlier, topography and ground roughness can be an effective moderating effect on winds near the ground. Recent studies in different centres indicate that the wind speed could be doubled near a hillcrest or reduced by half behind the protective shelter of hills. The wind force, which is proportional o the square of the wind, can thus vary widely between flat ground or near a hill. Techniques for evaluating the influence of terrain are now becoming available and useful results are emerging out of wind tunnel experiments. These experiments will help us to identify localities that are most vulnerable to strong winds.

Summary and conclusions

The main conclusions of this review may be briefly summarised as follows :

(i) Nor'westers are small scale severe thunderstorms which come under the general category of wind storms. They are recognised as a natural hazard under the International Decade for Natural Disaster Reduction (IDNDR) in the 1990s.

(ii) For sudden onset disasters, such as Nor'westers, the lead time for an effective early warning system is small, especially in view of current uncertainties in the mode of formation.

(iii) An intense research and observation experiment over a limited high resolution grid and for a 3 month period could be a good contribution to the International Decade for Natural Disaster Reduction (IDNDR).

(iv) The experiment may be supported by Doppler radars, fast response raingauges and numerical models.

(v) Disaster reduction measures are closely related to an accurate estimate of the wind speed. Isopleths of the maximum wind and their relation with the storm track are needed for this purpose. ☐

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NOR'WESTERS LOCAL SEVERE STORMS AND ATMOSPHERIC ELECTRICITY

A. K. SEN*

Nor'westers and local severe storms

Nor'wester is a local severe storm hailing, in general, from the north-west during the premonsoon season March-May, every year. It occurs over the eastern region of India originating from the hilly regions of Chottanagpur around Hazaribag and Asansol and travelling to West Bengal and Bangladesh by a regenerative drift process of repeated regeneration and intensification along its path of travel towards the south-east. The average speed of travel is about 30-40 miles per hour although windspeeds, around the thunderstorm may reach values as high as 70-80 miles/hr, causing severe damage of the life and property of the inhabitants in the eastern region. At the same time the violent downflow of air in the central region of the storm called the downdraft, is a potential hazard to aircrafts trying to land on airport at such times. Many such plane accidents have in fact, been reported from different parts of the world due to a kind of invisible and unpredictable downflow of air associated with a similar phenomenon known as 'micro-burst'. Besides these, the electrical activity in the thunderclouds associated with Nor'westers and local severe storms also occur on a large scale producing lightning discharges between cloud and ground causing lightning flash appearing as thunderbolts, which may cause damage to buildings, power lines and electrical installations. At the same the oxides of nitrogen produced by the electrical discharge in the air during a lightning flash, are dissolved in the raindrops which after falling on the ground increases the fertility of the soil and food production.

Lightning discharge and electromagnetic radiation

The lightning discharge also produces electromagnetic radiation causing radio-noise over a wide range of radio wavelengths in the frequency range 1 kHz to 1000 MHz with a maximum occurring around 10 kHz. These appear as atmospherics in radio receivers and is a potential hazard to radio communication, broadcast and television services. At frequencies below about 30 MHz, the radio noise due to a lightning discharge may propagate to long distances by reflection in the ionosphere and disturb radio communication over a wide area around a thunderstorm centre. In the LF/VLF bands between 3-300 kHz, the base of the ionosphere and the Earth's conducting surface behave as a spherical waveguide and allows the radio-noise from a lightning discharge to propagate within a radius of about 6000 km, affecting radio navigational aids and worldwide dissemination of atomic clock timing services which operate in the VF/VLF bands. The radio-noise due to all the thunderstorms occurring within a radius of 6000 km of a LF/VLF receiver will, in fact, be received as atmospherics and determine the minimum level of signal which can be detected by the receiver.

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Electric charges of thundercloud deposited on Earth and electric field of fair weather

The lightning discharges also tend the charge up the earth negatively and about 50,000 thunderstorm centres operating round the world maintain a negative charge of the earth.

Each individual thunderstorm generates a net upward directed current due to a electrification of the thundercloud, with positive at the top and negative charge at the bottom of the cloud. The current charges up the spherical shell capacitor formed by the base of the ionosphere and the surface of the Earth, acting as a spherical shell capacitor. The capacitor discharges by a downward current in areas of the Earth where there is no thunderstorm and fair weather conditions prevail. The magnitude of the downward vertical current is a few times 10^{-12}. A per square meter of the Earth's surfaces, and the vertical potential gradient, causing the current to flow, is about 100 V per meter at the surface of the Earth. The order of the discharging current and the potential drop across the capacitor are determined by the vertical columner conductivity of the atmosphere. Throughout most of the lower and middle atmosphere, the conductivity is determined mainly by the ionization produced by the cosmic rays of galactic origin. Solar cosmic ray or proton emissions during outstanding solar flare events may increase the conductivity and decrease the potential drop. An opposite effect is expected due to 'Forbush' decrease of galactic cosmic rays caused by sudden changes in geomagnetic fields during a solar flare event, appearing as magnetic chrochette.

The perturbations induced by solar particle events are accompanied by calibrated changes in atmospheric conductivity and, therefore, have got great implications in the understanding of the mechanism of generation of fair weather electric field.

There have been claims that the development of thunderstorms may be affected by the magnitude of background electric field, which would allow solar particles to influence global convective thunderstorm activities through the changes of atmospheric conductivity as indicated above. Changes in galactic cosmic ray flux, such as Forbush decreases, would likewise affect thunderstorm activities[8].

Charge generation in thunderclouds

In July 1750 Benjamin Franklin was the first to propose an experiment on thunderstorm electricity. He suggested that a sentry box, large enough to contain a man and an insulated stand, be placed at a high elevation and that an iron rod 20-30 ft in length be placed vertically on the insulated stand, passing out through the top of the box. He then proposed that a man stand on the floor of the box and bring near to the rod one end of a piece of wire, held by him by an insulating handle, while the other end of the wire was connected to the ground. With this set up, an electric spark jumping from the rod to the wire, just before connecting the wire to the rod would prove cloud electrification. The experiment was risky. For, if a lightning happens to strike the rod, the man would be killed instantly. Franklin did not realise this potential risk. Two years later, the proposed experiment was set up on 10th May 1752 in Marly-la-Ville in France by d' Alibard and an old soldier, called Coiffier, brought an earthed wire near to the iron rod while a thunderstorm was overhead and saw a stream of sparks as expected by Benjamin Franklin. This was the first direct proof that thunderstorms were electrified. This was "the greatest discovery that had been made in the whole compass of philosophy since the time of Sir Isaac Newton", as remarked by Joseph Priestly. Later in the same year before hearing of d' Alibard's success, Franklin carried out his famous kite experiment in Philadelphia and observed sparks to jump from a key attached to a kite striking to the knuckles of his hand. Franklin erected an iron rod on the chimney of his home and identified on 12 April 1753 the sign of the charge collected on the lower end of the rod when thunderstorm passed over and this led him to conclude that "clouds on a thundergust are most commonly in a negative state of electricity, but sometimes in a positive state —the latter, I believe, is rare". During the 2nd decade of the 20th century C.T.R. Wilson, infact, showed that the lower regions of thunderstorms are generally negatively charged while the upper regions are positively charged.

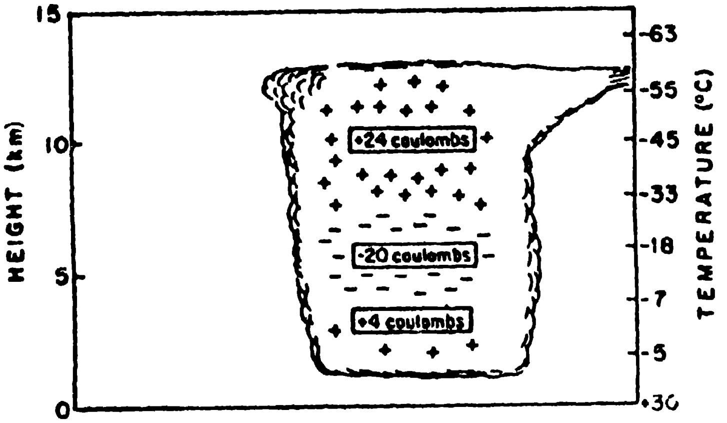

Fig. 1. Distribution of charges in a thunderstorm.

The distribution of charges in a thundercloud has been investigated experimentally with (1) special radiosondes called altielectrographs, (2) specially instrumented aircraft and (3) by measuring the changes in the electric field at the ground that accompany flashes. These studies have shown that, thunderstorms contain positive charges of about 24 Coulombs (C) in their upper regions, negative charges, about20—C lower down but above the 0°C isotherm, and a much smaller pocket of positive charge, about +4C just below the melting point for ice as shown in Fig. 1. The rate of generation of charge in a thunderstorm is believed to be about 1 Coulomb per cubic kilometer per min. The pocket of small positive charge tends to follow precipitation within the cloud. However, the existing theories of charge separation are concerned with two main charge centres in thunderclouds with a positive upper charge and a negative lower charge centre. The small pocket of positive charge observed just below the 0°C melting level in the mature stage of a thunderstorm originate presumably from the charging of solid icy precipitation particles on melting, as they fall through the 0°C level.

Lightning flash, thunder and cloud electricity

The onset of strong electrification and charge separation in thunderclouds occur after the appearance of heavy precipitation within the cloud in the form of graupel or hailstones, which are presumed to play an important role in the charge separation. With the progress of charge separation in a thundercloud the potential gradient between the cloud and ground, and between various regions of the cloud, increases and eventually exceeds a critical level, when dielectric breakdown occurs to form a lightning flash. Cloud to-ground lightning flash is initiated near the negatively charged cloud base in the form of an invisible discharge, progressing downwards in several discrete steps through what is called a stepped leader stroke. Each step lasts for about 1 μ sec during which the leader advances by about 50 m. The stepped leader releases electrons, which neutralize the small pocket of positive charge in the cloud and then it moves towards the ground, inducing positive charges on the ground, specially on tops of trees, buildings and other protuding objects. On reaching within 10-100 m from the ground a travelling spark moves up from the ground and meet it establishing a preionized conducting channel between cloud and ground. As a result numbers of electrons flow to the ground from the cloud base through the ionized channel to produce an upward current of the order of 20,000 amperes. This is called a return stroke This large current raises the temperature of the channel of the air through which it passes to above 30,000°K producing a lightning flash during the discharge. It occurs so suddenly that the air gets no time to expand and the pressure in the channel increases instantly to 10-100 times the atmospheric pressure. The high pressure channel then expands rapidly into the surrounding air and creats a very powerful shock wave which travels faster than the speed of sound initially and than gradually reduces to acoustic speeds, and heard as a thunder. A thunder can, in fact, be heard upto a distance of about 25 km from a lightning discharge.

The first return stroke may be followed by subsequent strokes along the same ionized channel, if additional electrons are replenished at the cloud base within 100 msec of the cessation of current. Most lightning flashes contain 3-4 strokes of lightning discharge separated in time by about 50 m sec, and these can eliminate the 20 coulomb of charge in the lower region of a thundercloud. Fresh charge separation within the cloud must then occur before another lightning flash may be expected.

The use of lightning rods was first suggested by Benjamin Franklin in 1749, to protect tall structures from damage by routing the strokes to the ground through the rod rather than through the structure itself. There is a belief that a lightning rod while protecting a building tends to attract lightning discharge falling on it. This apprehension appears to be baseless. For, the lightning rod helps to reduce the induced positive charge by leakage through the sharp spokes projecting upwards from the rod. This reduces the chance of lightning, striking over the region around the lightning rod, rather than inviting it. At the same time, if the charge leakage from the rod fails to stop the lightning strike the current will be conducted by it avoiding the damage to the building.

Electrical activity as a signpost of thundercloud development

The electrical activity of a thundercloud reflects the state of development of a thundercloud right from the initial stage through the mature stage to the decaying stages of thunderstorm development. The charge separation in the thundercloud is detectable from ground by observing its influence on the vertical potential gradient observable from the ground, particularly when it is overhead or near the observing site. With the progress of the thundercloud development when precipitation starts at cloud level, an enormous increase of charge separation occurs causing lightning discharges in the cloud and ground. These discharges are observable even from a remote location by receiving the electromagnetic radiation from the discharge appearing as atmospherics in the LF/VLF bands.

The integrated field intensity of atmospheric (IFIA) observed on 30 kHz at the Institute of Radio Physics and Electronics, University of Calcutta have, in fact, indicated that IFIA starts rising gradually right from the initial stage of the cloud development at the place of origin, near Hazaribag or Asansol[1] and exhibits a sudden increase around 1400 hrs. when the thunderstorm reached a stage of maturity producing precipitation. The storms originating from Hazaribag ultimately reach Calcutta about 5 hrs later at 1900 first, while these at Asansol reach 3 hrs later at 1730 hrs.

Formation of Nor'westers and local severe storms

Nor'westers and local severe storms of this type occurring elsewhere in West Africa and over middle latitude land areas, including much of the central and eastern United States, form only in a convectively unstable environment in which there is considerable vertical wind shear between low level flow of moist warm air and that of cold dry air at the upper levels. In such an environment, convective precipitation systems can develope rapidly and persist for long periods of time in their mature stage without destructive interference between updrafts and downdrafts. The majority of severe thunderstorms, therefore, produce flash floods, large hail and high winds. In case of Nor'westers, incursion of warm moist air from the Bay of Bengal to the hilly regions of Chottanagpur at lower levels and the cold dry wind from the North flowing in opposite direction at a higher level forms a high level surface of discontinuity. The initial convective activity near the hilly area produces cumulus clouds which on reaching the high level surface of discontinuity shoots up with explosive violence producing a dense cumulonimbus

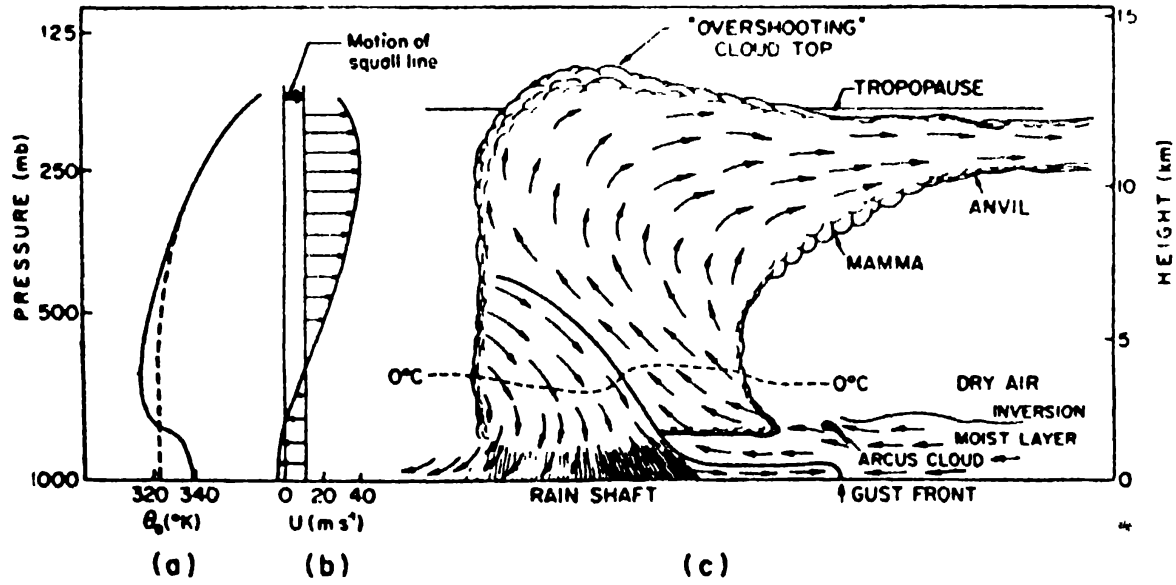

Fig. 2. Vertical distribution cloud, rain and atmospheric parameter during a Nor'waster or local severe storm ; (a) (left) Vertical profile of equivalent potential temperature prior to the storm (solid line) and just behind the squall line (dotted line). (a) (right) Vertical profile of horizontal wind component in the direction of motion of the squall line, with a velocity scale relative to the ground, the arrows representing velocity relative to the squall line. (b) Cloud outline and air motions relative to the squall line.

cloud. The updraft in this developing stage is so high that it can keep a man floating in the air if he happens to arrive somehow to the central core of the violent updraft. In the mature stage a severe downdraft starts carrying in heavy precipitation. Cumulonimbus towering clouds are often arranged in long lines in which adjacent elements are close together to form a mesoscale system that can be regarded as a line 'thunderstorm'. Such storms are often accompanied by gusty surface winds and hence the name 'squall line'. The vertical profile of horizontal wind component in the direction of travel of the squall line and the cloud outline and air motions relative to the squall line are shown in Fig. 2(a) and 2(b) respectively. Fig. 2(a) also includes the vertical profile of equivalent potential temperature before and during the storm (leftmost figure). Potential temperature is, in fact, and extremely useful parameter in atmospheric thermodynamic phenomena like storms. For, the atmospheric processes involved are often close to adiabatic for which the potential temperature remains essentially constant. The potential temperature of an air parcel, defined as the temperature which a parcel of air would have if it were expanded to a standard pressure p_o (generally taken as 1000 mb) is considered.

The great depth of the cloud makes it appear black due to obstruction of daylight passing through it.

A distinctive feature of most squall lines is the gust front which marks the leading edge of the advancing wedge of cold downdraft air. A sudden drop of temperature by about 10°C is the common experience of all during the onset the gust front over the observer, during a Nor'wester.

Hazard to aerial navigation due to downdraft

The region of downdraft is a potential hazard to aircrafts trying to land through it. The danger in landing of the aircraft through a downdraft is illustrated in Fig. 3.

The path of descent of the aircraft on the runway is shown dotted. An approaching aircraft encounters headwind, impinging from the front or head, towards the tail, causing a lift up of the front. During escape from the downdraft region it faces tail wind which drags

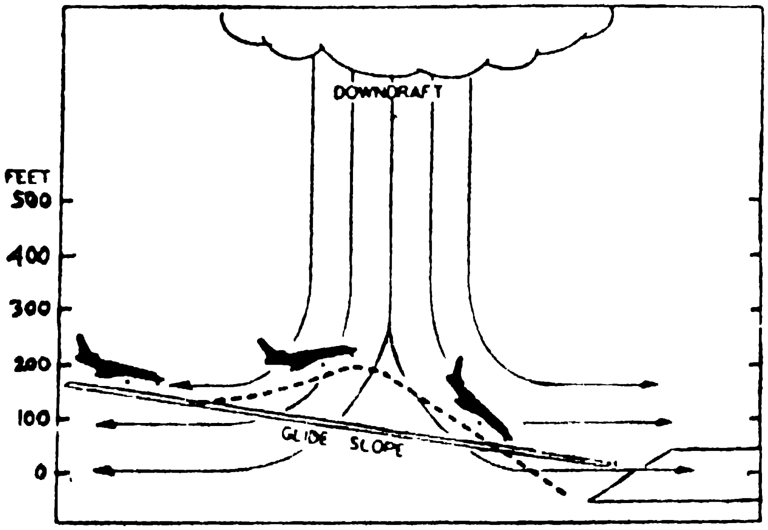

Fig. 3 Downdraft of a microbust causing aircraft accident by tailwind blowing over it during escape from the downdraft regions

it down below the line of descent to crash land on the runway at a high elevation angle, destroying the aircraft altogether A storm warning radar installed at each airport warns a pilot about impending Nor'westers and local severe storms before he may try to land. There is, however, a class of storms in which the downdrafts occur without any visible sign. These are called 'microbursts' which have caused accidents in various parts of the world during the landing phase of an aircraft. Microbursts are detectable by Doppler radars which are coming up rapidly to avoid such accidents in aerial navigation.

Studies of Nor'wester and local severe storms

Local severe storms like Nor'westers are difficult to study with a limited number of IMD stations equipped with meteorological sensors which are also too sluggish to record the fast changes of temperature, pressure, humidity, wind speed and wind direction. A much higher resolution both in time and space are essential merely to register the fast changing meteorological parameters with a reasonable spatial resolution in three dimensions upto a height of at least 10 km to which the cumulonimbus thundercloud may extend. The wide geographical coverage of a Nor'wester extending right from the source region in the hilly areas of Chottanagpur down to the Bay of Bengal coast in the south and, perhaps, to Dacca and beyond, in the east makes it necessary to undertake observations with a close grid automated mesonet of surface meteorological observations for understanding the mechanism of regenerative drift over the region.

Recently, a three dimensional resolution of the thundercloud development, associated wind and rain patterns over a horizontal range upto 50 km and vertical range of 10 km, has been possible with the advent of dual polarisation Doppler radar in the S-band. A few such radars supported by the close grid mesonet would, perhaps, be the ideal facility to probe deeper into the violent thunderstorm phenomena like Nor'westers. With this objective in view the Atmospheric Science Department of the University of Calcutta initiated by the UGC and three other Departments : (1) Institute of Radio Physics and Electronics, (2) Applied Physics and (3) Applied Mathematics supported by the Computer Science Department have undertook a joint programme of study on "Nor'westers and local severe storms'. Some experiments using fast response sensor's of temperature, pressure, humidity, wind speed and wind direction have already been started through a project sponsored by the DST. Further plans are in process to install (1) an X-band Met Radar, (2) a dual polarisation Doppler radar, (3, a close grid automated mesonet, (4) instrumented tower, (5) lightning detectors, (6) atmospherics receivers, (7) potential gradient recorders, (8) fast response rain gauges and (9) distrometers, for raindropsize distribution measurements, in collaboration with the India Meteorological Department and National Airport Authority. □

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Notes and news

Nehru Research Centre

Nehru Centre for advanced scientific research in theoretical physics will be set up in commemoration of his service as India's first Prime Minister in the independent era pursuing science research for the first time on a massive scale. It is announced by Professor C. N. R. Rao, the director of the Indian Institute of Science (IIS) who is also to act as the President of the Nehru Centre that this 16-million dollar centre will be structured along the lines of the International Institute for theoretical physics at Trieste in Italy.

Professor Rao has indicated that the centre will be devoted to scientific research at the highest level in the frontier areas of absorbing interest. Moreover, it will have access to the workshop and the laboratories of IIS for experimental work. According to Professor Rao, the centre is registered as a non-profit society with the objective of providing an excellent environment for education and research.

The centre, in addition, he says will act as a national and international forum for exchange of ideas through seminars and summer schools. It is further revealed that the centre will have full-time faculties, honorary and visiting professors as well as the renowned research scientists.

Professor Rao hopes that the new centre will help to plug ' brain drain" by attracting Indian intellectuals now drawn to Trieste because similar research facilities will henceforth be available in the country. ☐

P. C. Bhattacharyya

National Symposium on Bioactive Compounds from Marine Organisms

Annamalai University, Centre of Advanced Study in Marine Biology will hold National Symposium on Bioactive Compounds from Marine Organisms during December, 1989. Contributed research papers are invited for presentation in the following sessions ; (i) Non-toxic bioactive substances ; (ii) Plant, animal and microbial toxins ; (iii) Antitumor, Antiviral and Antimicrobial compounds ; (iv) Chemistry and pharmacology of bioactive compounds ; (v) Ecological interactions ; (vi) Prospects and potentials.

Abstracts must be sent by 30 October 1989 and paper by 30 November 1989. For more details, contact Prof. A. Subramanian, Centre of Advanced Study in Marine Biology, Parangipettai-608 502, India. ☐

National Symposium on "Environmental Influences on Seed and Germination Mechanism—Recent Advances in Research and Technology"

The above symposium which is being organised by the Department of Botany, University of Jodhpur will be held from January 27-29, 1990. The objectives of the symposium are : (1) Seed morphology, polymorphism and their ecological significance. (2) Soil seed reserve, its dynamics in arable land, and seedling demography. (3) Seed dormancy, germination behaviour, and quantification of germination. (4) Halophytic seeds and their germination strategies. (5) Physiological and biochemical changes during germination. (6) Bioregulators on germination mechanism in crop seeds. (7) Seed pathology, seed testing and plant quarantine. (8) *In vitro* embryogenesis.

Further details may please be obtained from Prof. David N. Sen, Director, Professor & Head, P.O. Box 14, Department of Botany, University of Jodhpur, Jodhpur-342 001, India. □

Enlightened Ignorance

..."Lewis Thomas whimsically wished for 'formal courses in medical school on medical ignorance' to address this century's 'discovery that we are profoundly ignorant about nature'. Indeed, the rapid increases and changes in information technology in medicine have exposed a vast realm of ignorance in human biology and revealed the transiency of accepted knowledge and the shortcomings of instructional methods that foster rote memorization, excessive reliance on conflicting data bases, and short-answer testing. Thomas' written wish actually served as the catalyst for U. Arizona Coll. of Medicine to remedy these serious deficiencies by introducing a curriculum in Medical Ignorance in 1985 The curriculum consists of seminars and hands-on clinical and laboratory experiences dealing with 'what we know we don't know, what we don't know we don't know, and what we think we know but don't.. Students repeatedly praised the seminars and hands-on experiences for bringing home how medical ignorance abounds, putting their knowledge into perspective, reinforcing knowledge, reawakening curiosity and enthusiasm, teaching them not to accept any information at face value, demonstrating that considerable effort and knowledge are needed to know you do not know. and showing that you learn and remember much more about a subject by concentrating on what is not known about it. The course instructors were impressed not only by how closely the students' comments about their basic and clinical science curriculum reiterated national concerns expressed in recent reports but also by how effectively this brief formal exposure to medical ignorance rekindled enthusiasm for learning..." □

Journal of Medical Education 63(10), 793-5, Oct' 88.

Ceramic Superconductor Wire and Foil

Ceramic superconductor wire and foil have been fabricated at the Central Glass & Ceramic Research Institute, Calcutta, by forming good adherent coatings of superconductor over metal wires and foils. The coating thickness is 50-100 μm and T_c around 90 K. Though the current density is not too high ($\sim$80A/cm), there is considerable scope for its improvement.

The technique employed is simpler and less expensive than the normally tried wire drawing method. It would be possible to fabricate continuous wires and strips by this method. □

CSIR News

Letters to the editor

Use of snail stomach cytase in clarification of somatic chromosome

Cytological preparation of somatic chromosome in ferns is difficult by conventional methods due to high chromosome number and the difficulty in hydrolysing the middle lamellae. This can not be removed by normal HCl treatment. Therefore, normal HCl treatment does not permit preparation of good root-tip squashes. In this direction, some success has been achieved by a few investigators[1-4] with the application of gastric juice from land snails (*Helix pomata* and *Achanita fulcata*). In the present work, the stomach cytase of water snail (*Pila globosa*) was used for good results.

The digestive tract of the local water snail was dissected out to locate the stomach after keeping the snail under starvation for 24 hr. The stomach cytase was then drawn out with a medico-syringe and collected in small glass bottles. These were either immediately used or stored in a refrigerator for future use. Freshly collected healthy root tips were pretreated with saturated solution of paradichlorobenzene at 18°C for 4 hr and then fixed in acetic alcohol (1 : 3) after thorough washing. The fixed root tips after washing in water were subjected to treatment with the stomach cytase for 5-10 min for softening the root tips to facilitate squashing. These were then rinsed with water and returned back to fixative. Finally, the root-tip squashes were made in 2% acetocarmine stain for cytological examination.

The well separated and properly flattened somatic cells at metaphase revealed $2n=90$ and $2n=60$ chromosomes in *Adiantum lunulatum* and *Cheilanthes farinosa*, respectively (Fig. 1). The root-tip squash preparations with admirable success clearly substantiated the fact that the stomach cytase of *Pila globosa*, a local water snail contains a mixture of enzymes which soften fern root tips through dissolution of the intercellular cementing material and thus allow preparation of good squashes for chromosome study. It is hoped that this would prove quite rewarding in the study of karyotypes of ferns which is quite scanty.

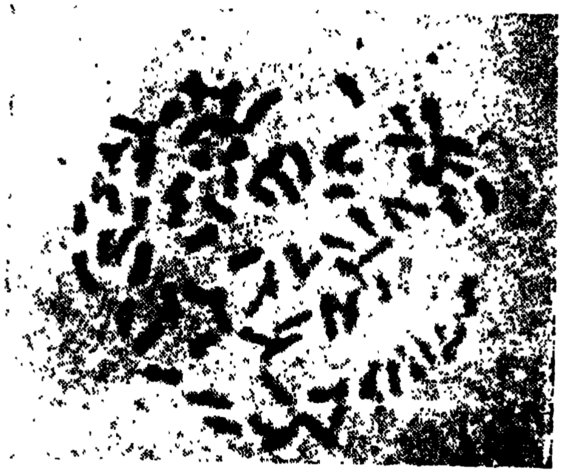

Fig. 1. Somatic chromosomes · *Adiantum lunulatum* $2n = 90 \times 2000$

The efficiency of the stomach-cytase extract towards digestion of middle lamellae in fern root tips varies with the toughness of material and the sources of the juice used. Niranjan and Roy[5] stated that the time required for softening the root tips is much less in case of water snails than that of the land snails. The high degree of effectivity of gastric juice of snails in softening the root tips is attributed to the highly active nature of enzyme complex which is presumed to contain helicase, pectinase, cellulase and others. It usually varies from 5-10 min (present study) to ½ hr for adequate softening while the land snail stomach juice normally takes a few hours to achieve the same end[4]. Enzyme assays of the juice of different kinds of snails and those from different habitats are expected to prove profitable in this context. Such work will throw further light on the variation of composition of the fern cell wall which now appears considerably different from those of higher plants. To find an evolutionary trend in this direction would be interesting in the literature on the biology of living ferns.

Thus, it can be concluded that stomach cytase of water snail (*Pila globosa*) proved to be highly rewarding in somatic chromosome preparation of fern root tips. The short pre-treatment revealed the highly active nature of the enzyme(s) extracted from *P. globosa*. The gastric juice of water snail was found more effective in dissolving middle lamellae in comparison to that of land snail.

The senior author (IPS) is thankful to Council of Scientific and Industrial Research, New Delhi for financial assistance as Senior Research Fellowship.

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Received : 14 October, 1988.

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Fungicidal control of cercospora leaf spot of mung bean

Cercospora leaf spot caused by *Cercospora canescens* Elis and Martin is one of the most serious diseases of mung bean [*Vigna radiata* (L.) Wilzeck]. The disease is widespread in occurrence[1,2]. It appears in severe form under the warm humid climate of India in Kharif season[3]. Results of fungicidal trials conducted in Kharif season in 1978 and 1979 are reported in this paper.

The fungicidal trial was conducted at the Orissa University of Agriculture and Technology, Central Farm, with cv. TT 2E and eight treatments in four replications in a randomized block design. Before sowing, seeds were treated with thiram (Tetramethyl thiuram disulfide) dry seed-dressing @ 1 g/ kg seed. Fungicides were used at recommended doses @ 500 l/ha of spray solution to spray the foliage, initially three weeks after sowing and this was repeated twice at fortnightly intervals. The disease index was scored one week after the last spray as a product of two rating scales (i) one for the size of spots and (b) the other for the number of spots as given below :

(a) Size of spots

Size	Score
Less than 1 mm	1
1 mm-2 mm	3
2.1-4 mm	5
More than 4 mm and coalescent spots	7

(b) Number of spots

Number	score
No spot	0
1-10 spots	1
11-25 spots	3
51-100 spots	7
More than 100 spots	9

Ten plants were randomly selected from each plot and from each plant five middle order trifoliate leaves were used for scoring—average from the ten plants being calculated to give the disease score per plant. Mean disease scores as well as grain yields were analysed statistically. Economic significance of fungicide application was determined taking into account the prevailing costs of chemicals and the produce in the local market. The data are presented in Table 1.

TABLE 1 : **Effect of fungicidal applications against cercospora leaf spot of mung bean (CV. TT. 2E)**

Treatment	Dose (%) (Commercial) Product	Disease score/plant			Yield of grain in g/plot of 12 m^2			Calculated yield in kg/ha	Net return per rupee invested
		1978*	1979*	Average	1978*	1979*	Average		
Bavistin	0.1	2.4	2.8	2.6	1195	890	1042	868	1.79
Blitox	0.5	5.8	8.2	7.0	750	446	598	491	0.22
Miltox	0.5	5.8	8.8	7.3	710	448	579	482	—
Dithane Z-78	0.5	6.0	7.7	6.8	658	386	521	435	—
Cuman-L	0.25	8.1	6.0	7.0	762	395	579	482	0.23
Benlate	0.1	2.5	2.6	2.5	1106	855	981	817	1.18
Difolatan	0.2	4.6	3.6	4.1	886	715	801	667	2.84
Control (water)		7.1	10.1	8.6	569	445	507	422	—
C. D. (5%)	--	2.03	1.31	—	346	268	—	--	—

*Average of 4 replications

Out of the seven chemicals tried, viz., bavistin 50 WP (Carbendazim), blitox-50 (Copper oxychloride), miltox (60% copper oxychloride and 37% ziram mix) dithane Z-78 (ziram WP) cuman-L (ziram liquid), benlate 50 WP (Benomyl) and difolatan 80 WP (Captafol), only three chemicals, viz., bavistin, benlate and difolatan gave significantly lower disease indices over the control consistently in the two test seasons and blitox, dithane Z-78, and cuman-L did well in the second season only. Amongst the former three, benlate and bavistin had almost similar effects followed by difolatan. Of them, only Bavistin and Benlate gave significantly higher yields over control in both the seasons. Difolatan also had appreciable effect that was significant in the second season only. Increase in yield per hectare over the control was highest with bavistin (446 kg) followed by benlate (395 kg) and difolatan (245 kg). Earlier Sivaprakasam and Murimuthu[4] found that only two sprays of bavistin at 0.5 kg/ha could effectively control Cercospora leaf spot of mung bean. Later, Ahmad[5] found that seed treatment with bavistin combined with only one spray with the same chemical provided adequate protection to the crop as well as substantial net return per hectare and rupee of investment. But our experience is that two sprays are not adequate to protect the crop at Bhubaneswar situation in Kharif. In this trial, the disease indices obtained with different chemicals in the two test seasons varied considerably, indices being generally higher in 1979 as compared to those in 1978. Total rainfall during the crop period was lower (405 mm) in

1978 than in 1979 (582 mm) and this may explain the higher disease indices in the second year. It seems that rainfall may influence the efficacy of different fungicides including the systemic ones like bavistin and benlate. This is in agreement with the findings of Ray and Addy[6] who observed that heavier rainfalls were associated with reduced levels of leaf-surface-residues of dodine and its efficacy against Citrus canker.

Though per hectare increase in yield over control has been highest with bavistin 50 WP (446 kg) followed by benlate 50 WP (395 kg) and difolatan 80 WP (245 kg), because of low input (chemical) cost, the return per rupee of additional investment has been the highest with difolatan (cost Rs. 85/kg) followed by bavistin 50 WP (Rs. 325/- kg) and benlate 50 WP (cost Rs. 345/kg). In the Rabi (winter) crop, because of less rainfall weathering, surface acting chemicals like difolatan, blitox-50, dithane Z-78, and cuman-L, which have been found here to be effective only in one season, may prove more effective and also economically viable because of their low cost.

This work was financed by Orissa Agricultural Development Project (World Bank), Coastal Zone, Bhubaneswar.

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Received: 12 September, 1988.
Revised: 7 June, 1989.

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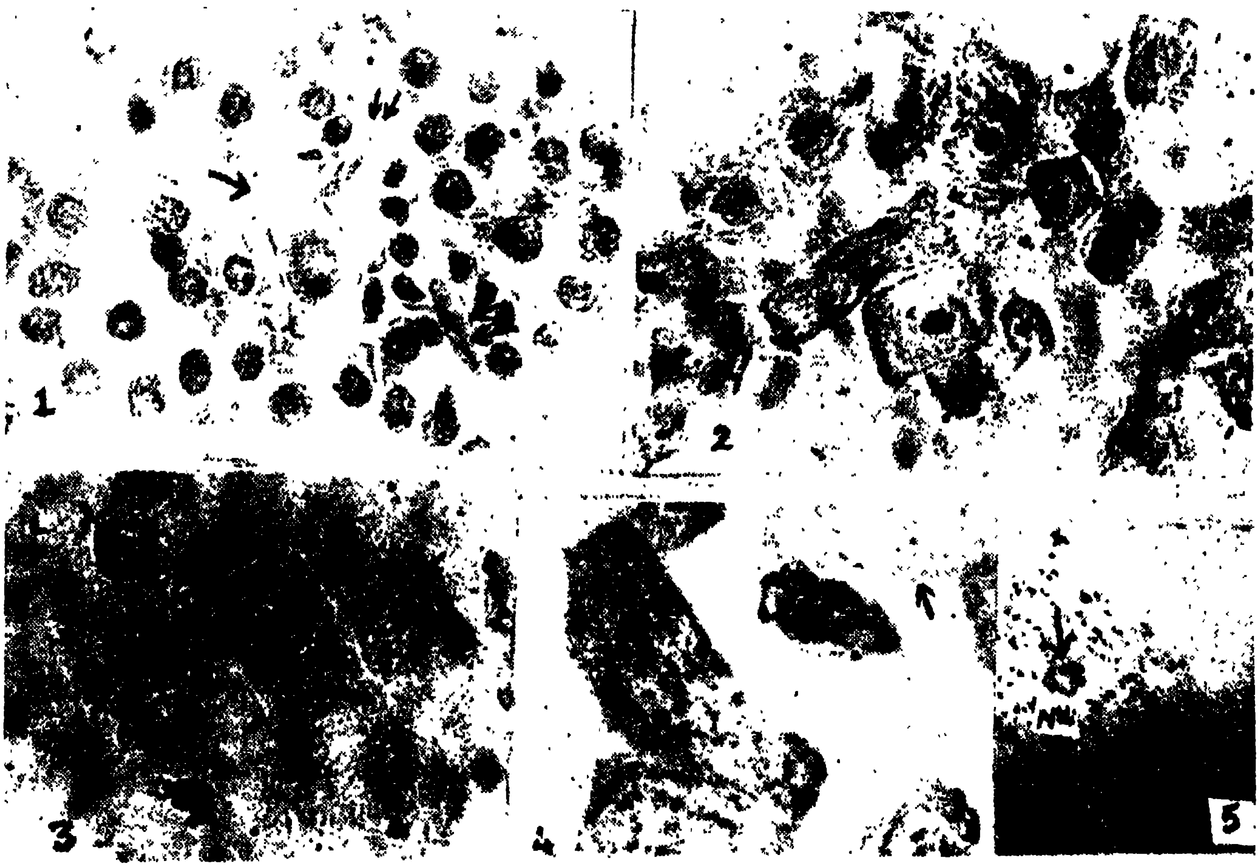
Interphase study—a silver staining of nucleoli

There are many techniques available for the selective staining of nucleoli and RNA-rich structures. Among them, recently developed silver-staining methods[1-3] have been widely used for the detection of nucleolar-organizing regions (NORS) in various organisms. From previous experimental evidence[4-5], it has been clear that these NORS which are actively engaged in the synthesis of rRNA during the preceding interphase could be stained by silver and silver-staining patterns reflect the function of ribosomal genes rather than their mere presence[6-7]. Schwarzacher *et al.*[8] made it clear that the Ag-granules are mainly associated with the fibrillar component of the nucleolus. Hofgärtner[9] demonstrated a positive direct correlation between the amount of silver precipitates over the nucleolar regions and the rate of rRNA synthesis. In view of the above findings, the author felt it desirable to carry out experiments on the ribosomal-gene activity of the interphase diploid and polyploid cells of the root-tip tissue of *Allium cepa* L. The technique developed by Olert[10] for selective silver-staining of nucleoli in interphase nuclei was followed.

Root tips of *A. cepa* were fixed in acetic acid and ethyl alcohol (1 : 3) overnight followed by storage in 70% alcohol, washed in distilled water and then treated with 5% pectinase at 40°C for 1 hr. Squashing was made and coverglass was detached in absolute alcohol and then air dried. To show the diploid and polyploid cells, 2% aceto-orcein was used. Seven parts of $AgNO_3$ solution (50% W/V in distilled water) were mixed with one part of 0.2% formic acid (in distilled water, adjusted to a pH of 2.5 with sodium formate), immediately pipetted on to the prepared slides and covered with a coverglass. Incubation in a moist chamber was followed until the preparations became a yellow to brown colour (5-30 min). The coverglass was removed by rinsing with distilled water and the slide was air dried. For autoradiographic technique, the method followed by Bhattacharya[13] was considered. The concentration of ^{3}H-thymidine was 2 μ C/ml and specific activity was 9.9 C/ml.

Figure 1 shows diploid as well as polyploid cells stained with 2% aceto-orcein. Polyploid cells are of two types: one with centrally placed large nucleus (single arrowed) and the other with very diffuse chromatin matter occupying the most part of the cell (double arrowed). This is confirmed by autoradiographic technique following ^{3}H-thymidine incorporation (Fig. 5). Polyploid cells adjacent to the root tip meristen may arise through endomitosis[13]. Chromosomes of these nuclei may be in polytenic condition of interphase or prophase state or may be in polyploid scattered polysomatic condition.

In Figures 2-4, the diploid as well as polyploid cells show one or two nucleoli stained black after silver-staining in a majority of the cells. But 1-2% cells (Fig. 4) show either scattered distribution of black silver grains or total absence (arrowed). Again, different pattern of silver-stained regions of the nucleoli is found (Figs. 2-3). In *A. cepa*, there is a single pair of NORs in metaphase chromo-



Figs 1-5: (1) Diploid as well as polyploid cells with interphase nuclei (One arrow indicates one large polyploid nucleus and double arrow shows diffuse chromatin matter in polyploid cells; (2) Variability in shape and number of nucleoli of interphase nuclei after silver-nitrate treatment; (3) One as well as two nucleoli in the polyploid nuclei; (4) Scattered distribution of silver precipitates over one large polyploid nucleus whereas one shows no silver grains (arrowed) and two diploid nuclei show 1-2 nucleoli in the cells; (5) One labelled polyploid nucleus after ^{3}H-thymidine treatment, depicting diffuse scattering of chromatin matter. Nucleolus is arrowed.

somes[11] and, therefore, two nucleoli are expected in diploid interphase nuclei. The variability in silver-staining of these nucleoli of the interphase nuclei indicates, as stated before[6-7], that silver-staining patterns reflect the function of ribosomal genes rather than their mere presence. Also from the Hofgärtner's[9] demonstration about a positive direct correlation between the amount of silver precipitates over the nucleolar regions and the rate of rRNA synthesis, it is obvious that all the nuclei in the root-tip tissue are not equally involved in synthesizing rRNA and the amount of rRNA synthesis itself differs from cell to cell. While the total absence of silver grains in few polyploid cells indicates the lack of ribosomal-gene activity, scattered distribution of silver grains (Fig. 4) indicates a profuse ribosomal-gene activity other than a pair of NORs or the presence of silver-stainable components deriving from the main nucleoli. Of course, polyploid cells are expected to be associated with NORs multiplications along with endomitotic division. In a majority of cases, polyploid cells show either one or two nucleoli bigger than that found in diploid cells. There is no ultrastructural evidence for nucleolar regions outside the main nucleoli in *Allium* microspores[12]. Thus, these fine silver granules may reflect a special functional state of the nucleus of these cells. Similar result was found in the nuclei of the diploid epidermic cells of *Allium cepa*[10]. Such variability in silver-staining of nucleoli were reported in different animal nuclei of different types of cells as well[10]. A complete lack of any silver precipitation has been noted in mouse sperms of a murine species[10].

Financial assistance by the University of Kalyani as personal research grant to the author is thankfully acknowledged.

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Received: *7 October, 1988.*

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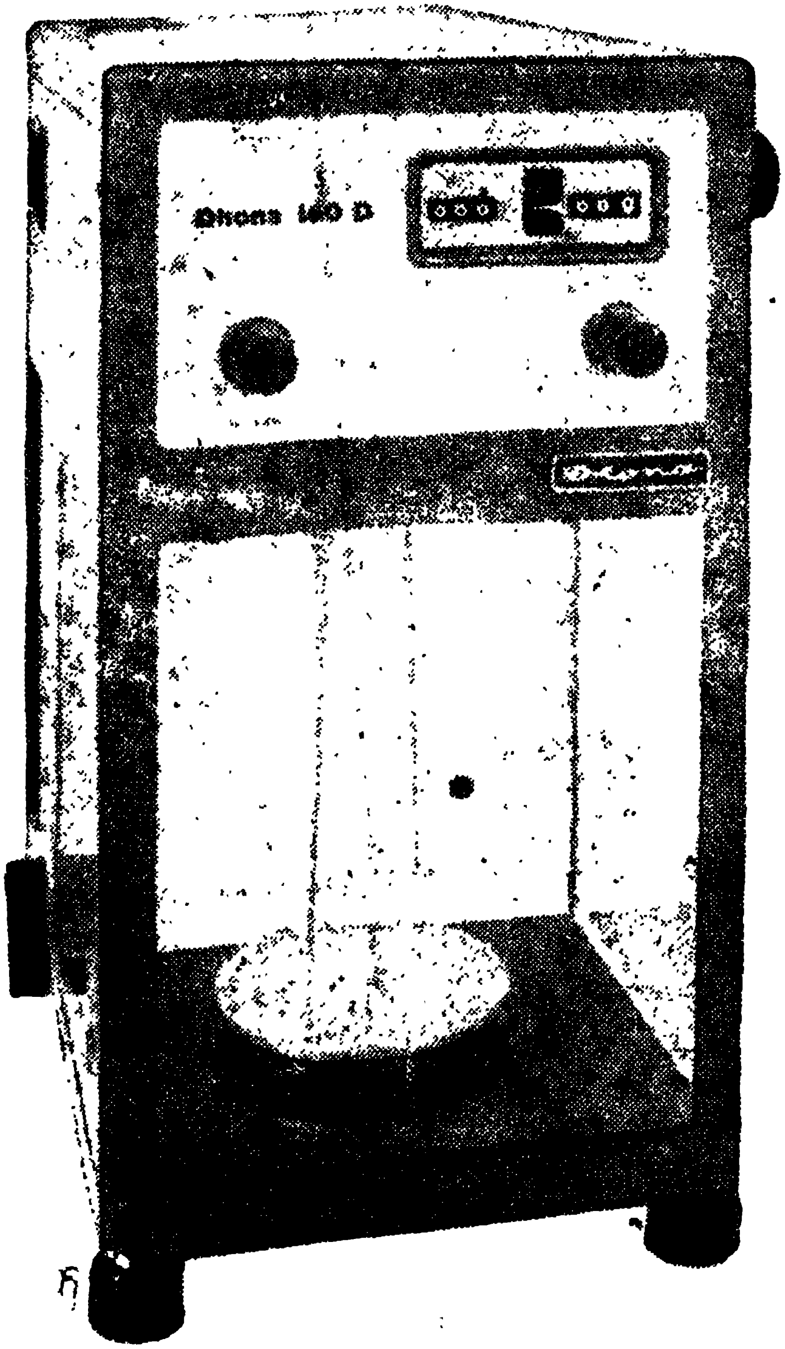

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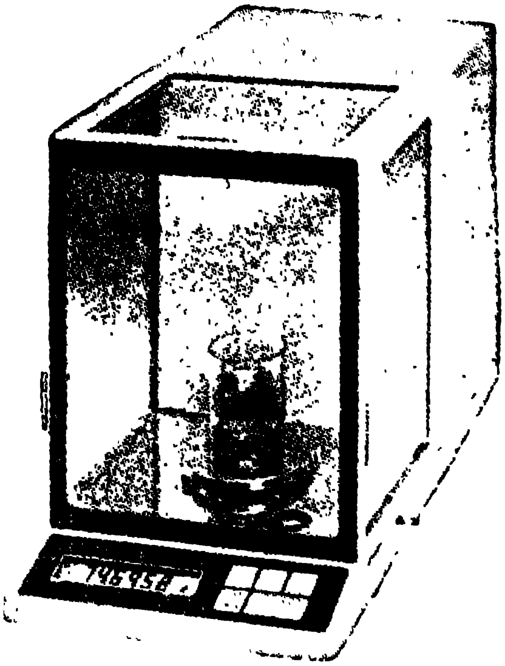

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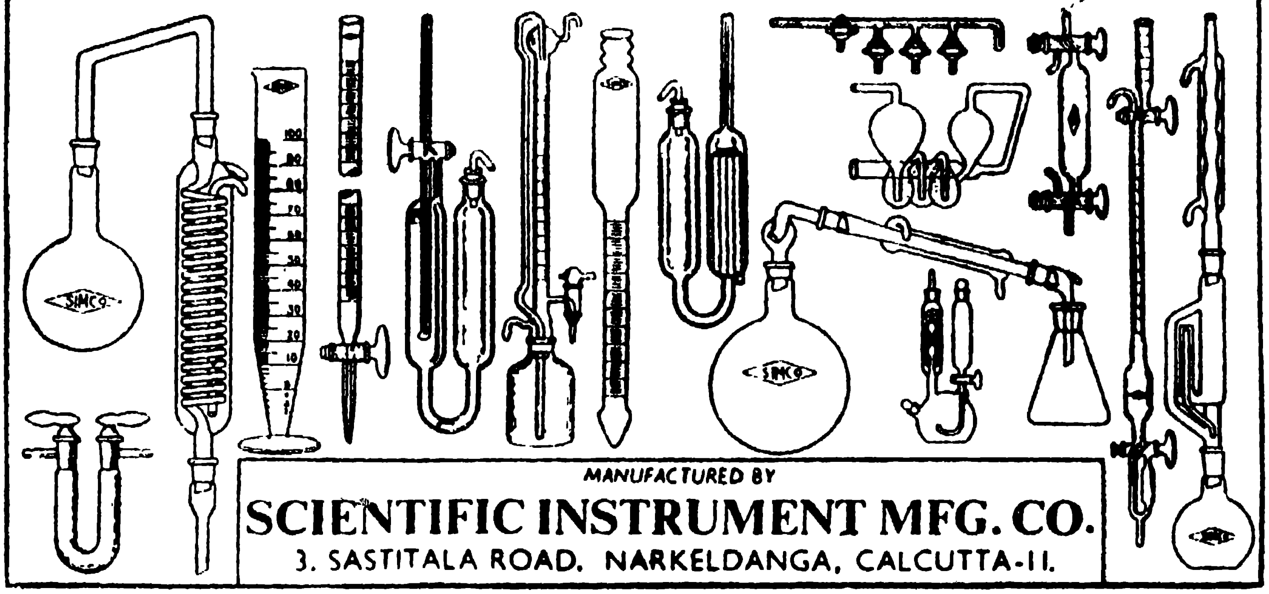

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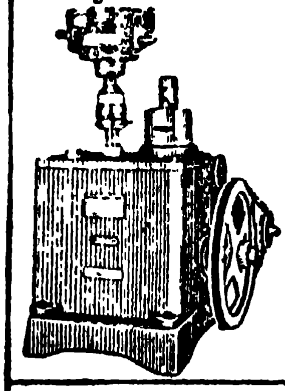

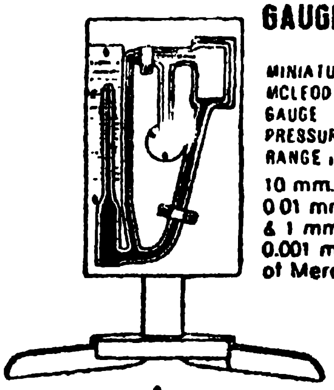

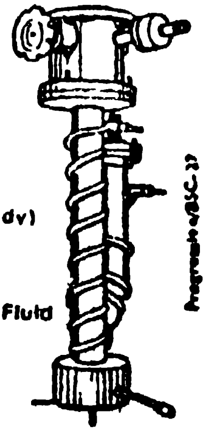

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September 1989 / Volume 55 / Number 9

PUBLISHED BY THE

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DISASTERS—NATURAL AND MAN-MADE (II)

(Continued from the last issue)

THE immense proportion that the problem of drought has assumed and their frequencies in recent years makes one think about the progress we have made since independence and the achievements of our five year plans The scientific approach that has been given to the planning process by our first Prime Minister Pandit Jawaharlal Nehru should have mitigated our woes due to drought. In these forty years, our water sources have not dried out like the mythical river Saraswati. Something else went wrong in our zeal for progress and development and that is the massive deforestation. To take care of this realisation, the government announced in 1985 the formation of a National Wasteland Development Board (NWDB) to arrest the denudation of our forests and to recover some of the lost forest lands. According to a report NWDB claims to have placed five million hectares under plantation during 1985-88. However, the claim has to be heavily discounted as no actual measurements were made and the estimates arrived at on paper were on the basis of the seedlings supplied. However, the causes of the debacle are deeprooted. They lie basically in the traditional lack of concern and lack of familiarity with the matter relating to the country's natural resources and its support system for which forests form only a part, though a most important one. This 'resource illiteracy' is the malady which lies at the bottom of most of the ecological troubles. In addition, there is the growing national tendency not to face unpleasant facts as long as they do not affect us immediately and personally This complacency about the most serious threats to the community is witnessed not only in the field of resource management but also with regard to other problems such as food production, population growth and poverty, etc.

Soon after our independence, in 1952, a comprehensive and complete national forest policy was formulated but it remained a dead document except for once in a year at the beginning of the monsoons, when it gives an opportunity to ministers and other dignitaries to inaugurate the function of 'Van-mahotsava'—which has become a mere ritual like many festivals in the country. The contents of the acts were never executed and the forest establishments deluded the nation and kept on reporting the same figures as 'area under forests' year after year. It came as a shock when in 1984, the satellite imagery revealed that out of the 67 million hectares area under forests hardly about 35 hectares were existing. And the rate of depletion is such that the extent of our forests at present cannot be more than about 24 per cent of the total land area as against 33 per cent recommended in the 1952 document and reiterated by the National forest policy of 1988.

What is required is an integreted approach to forestry, wasteland development, river water distribution and other environmental problems. They are all inter-related and require a comprehensive tackling The figures of expenditure on short relief for drought, flood and other similar calamities every year are really staggering. Could we not have approached the problem in a more realistic way ? At the root of several of these problems is proper water distribution in the country.

It is estimated that in the year 2000 A D when the population is expected to rise to 900 millions, the annual average quantity of water utilised will be about 830×10^9 m^3 out of which agriculture claims about 775×10^9 m^3. It is not difficult to meet this demand as the total annual average available water in all the rivers in addition to exploitable underground sources will be about 1900×10^9 m^3. However, the problem of the planners is how to tap sufficient quantity of water and ensure the equitable distribution for optimum benefit.

The problem is being thought over since independence and the former Union Minister for Irrigation Late K. L Rao (who was an engineer himself) had proposed a national water grid and during the seventies the Central Water and Power Commission sponsored it to some extent Several other agencies and individual entrepreneurs had proposed schemesfor mitigating the drought conditions prevailing in the country. Amongst these the garland canal scheme was an interesting proposal. Under this scheme it was suggested to intercept the entire subcontinental drainage by two mammoth canals (i) the Himalayan canal and (ii) the central and southern garland canals.

The schemes are quite attractive and if executed would solve many of our problems. However, if one examines them a bit more in-depth one can recognise that the national water grid involves several cuttings across ridges and mountains from 200 meters to 500 meters to transfer water effectively to the deficit areas and as such, requires enormous quantities of power. In a power deficit country it is practically impossible to earmark such large quantities of power for hydraulic lifts nor is it financially (and technically) sound to execute the deep cuttings or tunnelling required for conveying the water covering long distances Environmental impact of such project will also have to be carefully assessed. Under the garland of canals scheme both the gigantic canals are purported to be zero level canals at the unattainable altitudes ($\sim$ 1000 m and $\sim$ 500 m above mean sea levels respectively) to cater to the vast areas located at different elevation. If one looks at the physical, topological and geographical features of the country, it becomes clear that the scheme is contrary to them.

The post independence period witnessed the construction of several major irrigation and power production schemes. To name a few, the Damodar Valley project, Bhakra-Nangal dam on Sutlej and the Tungabhadra dams are really major achievements However, many of the reservoirs are loosing their capacities, hence utility due to silting and improper maintenance are causing grave environmental threats. It is this aspect of the development that has been taken by the local people which is strongly opposed to the Sardar Sarovar project (in Gujarat) on the Narmada and which is financed by the World Bank. Both the international finance agency and the Government are under the dilemma whether to pursue the project or abandon it. It is necessary to plan more feasible and effective projects of water distribution. During the British period in the last century Sir Arthur Cotton had contemplated linking the Godavary, Krishna and Kavery in the Southern part of the country. The project was not pursued because of the British Government, dubbing it as non-productive. This was taken up again in independent India, but the division of linguistic states and political situation in the country gave such a twist to the problem that the project of Telugu Ganga is still languishing in the 40th year of independence.

In fact, many of the natural shortcomings have been aggravated into calamity due to man's intervention in his environment and mismanagement. Many a drought can be faced with understanding and much of the distress could be reduced.

Man's advancement in science and technology is such that many a time a minor oversight could lead to disasters. In some cases the calamities are built up step by step due to deliberate negligence and oversight like the chemical pollution of the environment and the river and sea waters. On other occasions momentary miscalculation of man can lead to unexpected havocs like the Bhopal gas leak in our country or the toxic cloud over Seveso in Italy or the Three Mile Island disaster or the Chernobyl disaster which threatened practically one fourth of the globe.

Recent technological advances have provided the means of upsetting the intricate set of biological, physical and chemical interactions that make water essential for the very existence of humanity. Starting at the dawn of industrial revolution, more than a century ago, factories have dumped toxic wastes into rivers and streams (all over the world), killing fish and other aquatic lives. In the name of progress, lakes and reservoirs have been poisoned with pesticides, and on the beaches of many of the affluent countries garbage, raw sewage and medical wastes have washed up to spoil the fun of the oceans. Perhaps most ominous of all toxic substances have begun to foul the ground water reservoirs of the Earth, threatening the water we drink and use for agriculture etc. According to some, the situation has not reached crisis proportion, but has reached an alarming point alright. By dumping of toxic (and radioactive) wastes in some of the third world countries, the affluent ones have made them partners to fight the impending crisis which threatens to assume global proportion.

India's 'green revolution' and the self sufficiency in food production is based on pesticides. Today we use about 77 per cent of the world's total production of DDT and 94 per cent of the equally potential BHC. In case of Melathian, we use about 60 per cent. The interesting fact is that countries like the US, the USSR and West Germany banned the sale of these pesticides in their countries in the seventees. In terms of tonnage, at least 70 per cent of all pesticides used by Indian farmer has been identified by World Health Organisation as 'excessively toxic'. They have been either banned and severely restricted in most of the countries. But unfortunately the multinationals are pushing the very same materials here and our Insecticide Act of 1968 has rarely been invoked against any of the offending companies. It is also alarming that despite the agony of Bhopal, there is a total apathy shown by the government towards the problem, as practically no data is available on the subject. This is the lament of pollution control board.

It is stunning to read in a recent publication of the Rice Research Institute, Cuttack, that "Most of the high yielding varieties released so far are susceptible to major pests with crop losses ranging from 30 per cent to 100 per cent. The narrow genetic base has created alarming uniformity, causing vulnerability to disease and pests". Integrated pest management, which makes use of biological pest control agents, may be the possible solution to the dilemma. In Soviet Union, as an example, extensive use of plant pesticide in the form of *neem* is used. There are no instant solutions for the problem but concerted efforts can be diverted to look for workable alternative before the pesticides start taking the toll of live-stocks and even homo-sapiens instead of insects which are increasingly developing immunity.

Although safety records of atomic installations and nuclear power plants are very good, accidents like Three Mile Island and Chernobyl are grim reminders to the mankind of the vulnerability of unintended human failure. People have come to regard the nuclear installations as *Democles sword* over the humanity. With a number of nuclear power plants feeding the national grid, India has an ambitious programme of augmenting the nuclear power programme before the turn of the century. We have one of the finest records on occupational hazards in these plants and an article on the subject gives the precautions taken up to maintain and improve upon it.

Every village dweller dreams in his adolescent years of going and living in a city and enjoying its comforts and variety of entertainments. Many succeed in reaching the city by populating its overcrowded habitats and taxing its beleaguered facilities to pick up their shattered dreams. The rapid growth of small towns into cities and cities into metropolis are the phenomena of this century and are accompanied by their problems which are threatening to be calamitous in many parts of the world. The civic facilities of drinking water and proper sewerage for the millions are themselves big problems. Added to this is the burgeoning problem of garbage disposal. In earlier times when garbage used to be mainly organic it was easier to bury and allow it to bio-degrade in areas away from the cities. But with the advancement of science and technology, greater and greater percentage of garbage is non-biodegradable and threatens to take disasterous proportions choking the very existence of the cities. It has to be tackled by new technologies and sound scientific methods.

In these two issues of *Science & Culture*, we have tried to present some of the calamities that man has to face and how our knowledge of science and development of technologies help him to tide them over There are many more problems and it may be possible to present them in due course. □

B. B. Baliga

A PERSPECTIVE OF SEISMIC HAZARD IN INDIAN REGION

KAILASH KHATTRI* AND KEDAR KHANAL*†

This article addresses the problem of seismic hazard of the Indian region and discusses the probablistic estimates available for the same. The concept of earthquake generating processes are briefly presented and the way this information may be utilized in improving seismic hazard estimates are discussed. The regions of highest seismic hazard coincide the Himalaya and associated regions. The seismic risk is defined as the cost that may be incurred due to a possible earthquake. The risk is rising progressively due to urbanization, industrialization and building of large dams, nuclear power plants etc This calls for improved hazard assesment techniques in order to optimize mitigation strategies. Suggestions are offered for this objective.

Introduction

The human kind have had to counter natural hazards since time immemorial and they have tried to face and forecast them as well as they could in any particular age. Among the natural calamities earthquakes rank the foremost. They have claimed very large number of human lives and inflicted enormous economic disaster in the past. In order to appreciate the dimension of tragedy inflicted by earthquakes we recall that nineteen thousand lives were lost in the great 1905 Kangra (Himachal Pradesh) earthquake[6] and another eleven thousand in the great 1934 Bihar-Nepal earthquake[1]. The potential for such disasters has multiplied manyfold since those times because of the urbanization, development of high populationcenters, hydro-electric and nuclear power plants etc.

In modern times the concern for the safety from such natural hazards has prompted the development of scientific procedures for assesing hazards and mitigating them using the available technological advances. Such appraisals are indispensable for government policy makers as much as for the public at large who invest resources in private enterprise.

In this article we address the problem of seismic hazard in the Indian region and present the current state of understanding in this regard. Reference is also made to risk arising on account of seismic hazard. By seismic risk we here mean the socio-economic consequences of earthquakes which are dependent upon the socio-economic status of a region.

Causes of Earthquakes

The earthquakes are a direct evidence of the dynamism of our planet. During earthquake occurrences our notion about "Terra Firma" are soundly shaken Most earthquakes are caused by tectonic processes in which due to relative movements of the adjecent rock materials strain develops and accumulates near the surface of the earth over a period of several tens to hundreds of years. This strain is what finally fractures the rocks rather suddenly to cause surface damage by the direct dismembering of man made structures and by shaking due to the seismic waves which are also generated in the process.

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The root cause of the dynamism of the planet lies in its internal heat. This causes the rock materials to behave plastically at depth as the temperature rises within the earth. Thermal convection currents are set up for transporting the internal heat towards the surface. The outermost skin of about 100 km of the earth is cool enough to be rigid and behave as a brittle material This outermost shell is broken into six pieces which are known as lithospheric plates. These grand plates are underlain by asthenosphere where the rise in temperature allows the material to creep.

The plates are carried about by the underlying convection currents in the asthenosphere. The relative motion between them generates strains in the lithospheric plate margins wherever they are locked and are unable to slide past each other. This results in earthquakes allowing the plate to move and release the accumulated strain. Thus the earthquakes are mostly confined to the boundaries of the moving plates. Such earthquakes are known as interplate earthquakes.

The above global process explains the occurrence of most of the largest earthquakes. But some large earthquakes have occurred in regions far away from the plate boundaries. Such earthquakes are known as intraplate earthquakes. Their different tectonic processes may generate the required strains. Some earthquakes are of volcanic origin also.

A very major plate boundary runs through the northern part of the Indian sub-continent. This is defined by the majestic Himalaya ranges Here the Indian plate collides against the Eurasian plate. This collision process in fact is responsible for the birth of Himalaya. A simplified and generalized scheme of the process is illustrated in Figure 1.

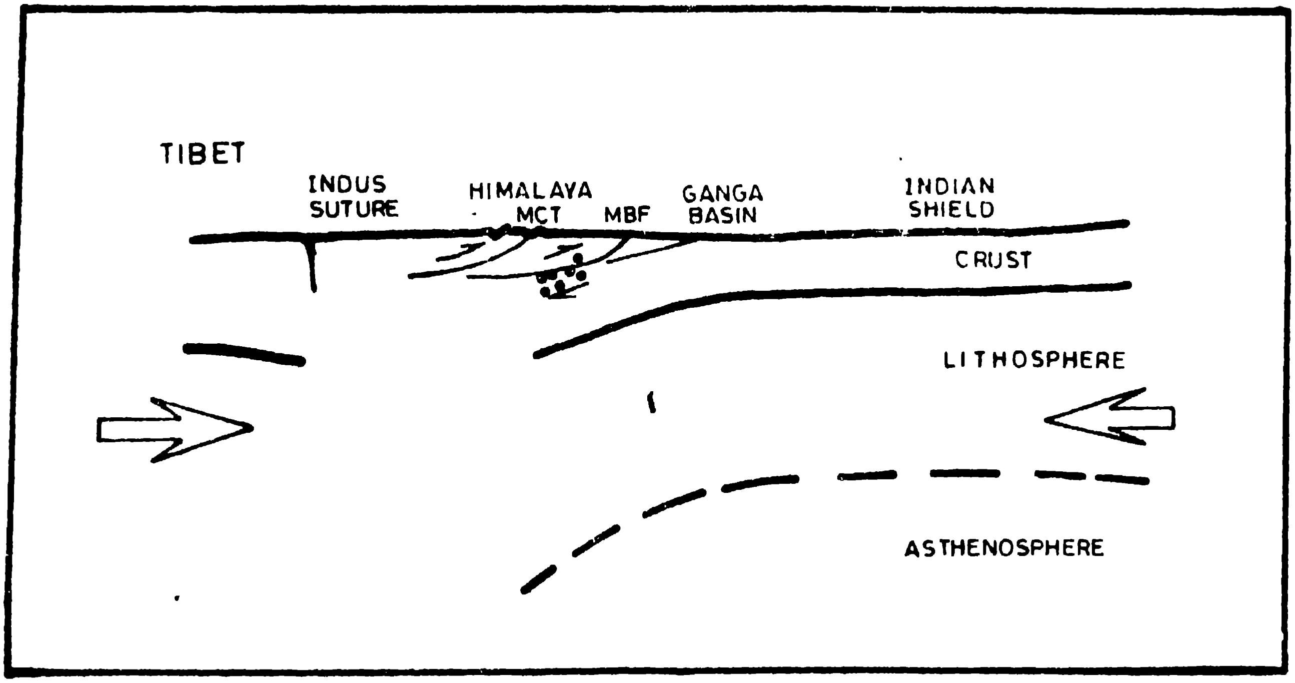

Fig. 1. Schematic diagram showing the underthrusting of the Indian lithosphere beneath Tibet that has given rise to the present day Himalaya.

Seismicity

The seismicity of the Indian region is shown in Figure 2. Here only the large earthquakes with magnitude M greater or equal to 6 have been shown. It is remarkable

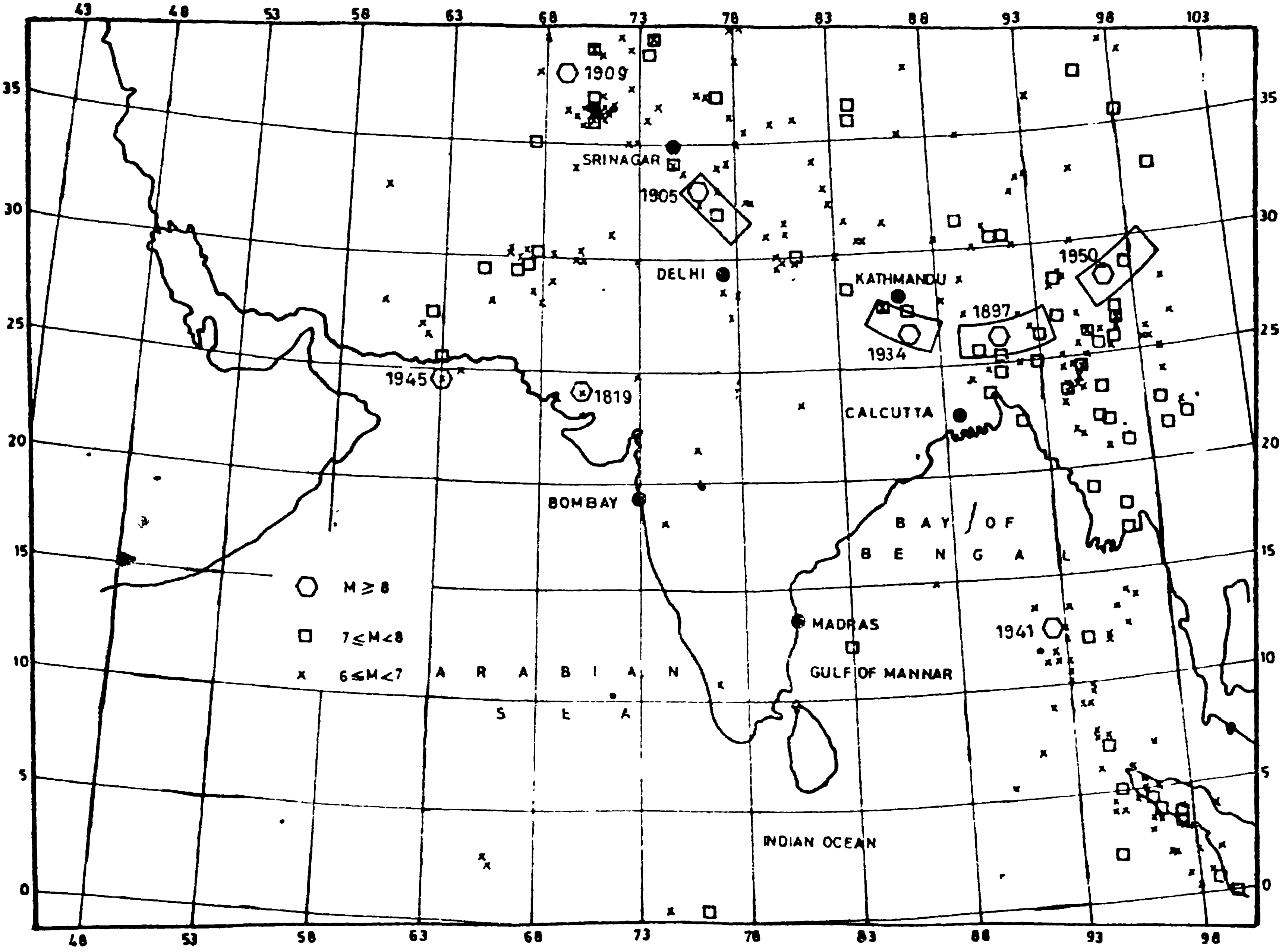

Fig. 2. Seismicity of the Indian region and adjoining areas. Earthquakes with magnitude greater or equal to 6 have been plotted. The boxes represent the estimated rupture zones of the great (M ⩾ 8) earthquakes whose year's of occurrence are noted next to them.

that the earthquakes mostly follow the Himalaya and associated mountain ranges. Only a few relatively smaller magnitude earthquakes have been recorded in the peninsular region of India. The greatest earthquakes with $M \geq 8$ have occurred along the main seismicity belt following the Alpide-Himalaya-Burma-Indonesia arc which is a plate boundary as noted before. The estimated rupture zones of the great earthquakes are shown by hatured regions. Although such ruptures may only rarely be reaching the surface of the earth for direct observations.

Seismic Hazard

The seismic hazard is defined here as vulnerability of any region to the effects of earthquakes. The effects of earthquakes may be categorized as follows.

1. The rupturing of ground along the primary and secondary fault surfaces in the focal region.
2. The tilting of the ground and elevation changes in the focal region.
3. The destructive effects brought about by the vibration of the ground due to generation of seismic waves by the earthquake. These include land slides, ground slumping and soil liquifaction, rending of trees and excitation of seiches i e., the setting up of oscillations in closed water bodies like lakes etc.
4. Generation of tsunamis by the faulting at the ocean floor.

Thus one may broadly group these effects into those which occur directly due to faulting and others which are induced by the seismic waves. The seismic hazard needs to be estimated for all of these phenomenon.

Although the broad framework for the occurrence of earthquakes has been well established that explains the 'why and where' of the earthquakes, the heterogeniety of the earth does not as yet permit the forecasting of the exact location, time and magnitude of the future earthquakes with reliability. This inability in part is also due to an absence of the measurements of the appropriate physical parameters that may characterize the earthquake processes adequately. It is therefore imperative that recourse be taken to model the occurrence of earthquakes by a stochastic process. It has been found that over large regions and large time intervals the earthquake sequences may be resonably represented by the Poisson's process. The earthquakes also display the law of fractals and as a consequence of which they obey the recurrence relation.

$$\log N(M) = a + bM$$

where $N(M)$ is the number of earthquakes with magnitude equal or greater than M ; a and b are parameters.

The earthquake hazard may be represented by its effects in terms of some ground shaking parameters. Commonly the force exerted by earthquake generated shaking is found to be a useful quantity. This is usually parametrized by peak ground acceleration. The peak ground acceleration will be a function of earthquake magnitude and distance of the point of observation from the earthquake source. This function of peak acceleration versus distance and magnitude has to be empirically estimated.

The main elements in constituting a seismic hazard map are : (1) the definition of seismic source zones, (2) the estimation of recurrence relation of earthquakes in each source zone ; (3) the estimation of maximum magnitude of a possible future earthquake in each source zone ; (4) the ground motion parameter mapped and its attenuation with distance as a function of magnitude and depth of focus ; and (5) the statistical model used to represent the occurrence of earthquakes.

Combining the above elements the maps of seismic hazard have been prepared for the Indian region in which the expected peak accelerations are contoured for a given probability of exceedence in a given exposure time interval[2-4]. In Figure 3 we show the probabilistic hazard map based on the work of Khattri *et al.*[4]. The peak ground acceleration values expected to be exceeded with a chance of 10% in an exposure period of 50 years have been contoured. The significantly high value of expected peak ground acceleration which attain values as high as 70% g (g = acceleration due to earth's gravity) are noticed in the Himalaya, Sulaiman and Arakan Yoma regions of high seismicity. These are regions

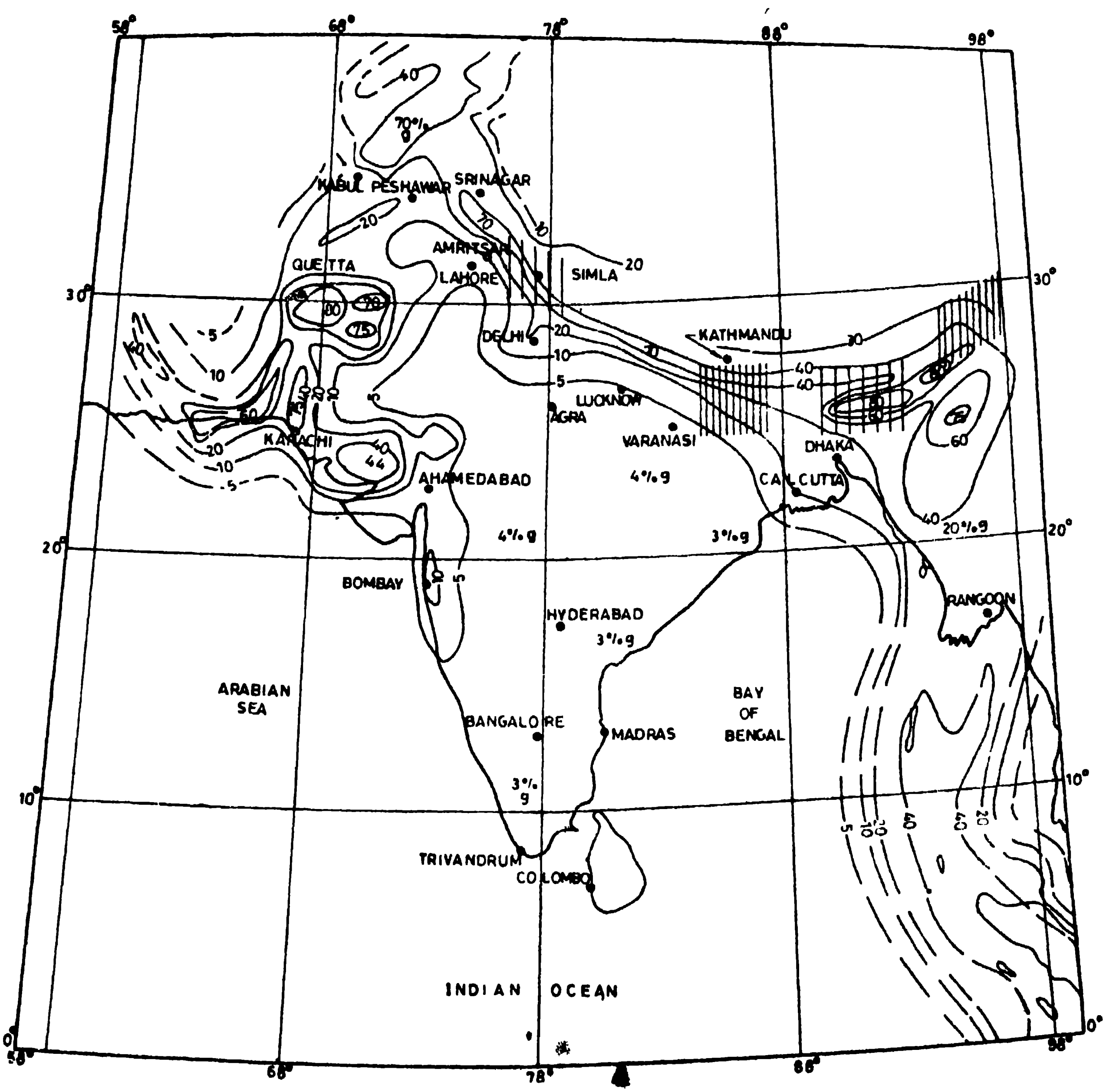

Fig. 3. The probabilistic hazard map of India and adjoining regions. The peak ground values expected to be exceeded with a chance of 10% in an exposure period of 50 years have been contoured. The hatured zones cover the rupture zones of great earthquakes that have occurred since 1897. In these zones the hazard is estimated to be lower than shown by the contours. Closure the hature lines smaller the hazard.

of high seismic hazard. The peninsular India is characterized by peak ground acceleration values of less than 5% g. The highest estimated peak acceleration value of 80% g is obtained in the regions of Shillong massif and of Quetta in Pakistan. In the western coast around Bombay the estimated values are around 10% g. The Sindhu Ganga plains have about 10% g expected peak acceleration which increases to about 20% g towards the foot-hills in the north.

Discussion

Seismic Risk : Seismic risk is defined here in terms of the cost of the socio-economic losses that may be inflicted by earthquake effects. Thus we may have a scaling factor to obtain seismic risk, may be in terms of Rupees (if every loss could be so defined !) from seismic hazard. Quite obviously given the same seismic hazard in two regions the risk may be quite different depending on the socio-economic status of the region Seismic risk will also be a function of time. In this respect the risk in various regions of our country has been rising progressively due to the urbanization, industrialization and the building of great dams in the Himalaya. For example an estimated investment of over Rupees 50,000 crores and a potential of further investment of atleast as much more in the multipurpose dams for hydroelectricity and irrigation brings the situation into sharp focus. The need to improve and optimize the hazard assessment and mitigation techniques is quite clear.

The ultimate in seismic hazard assessment is the capability to accurately predict future earthquakes in terms of their magnitudes, time and place of occurrence. The prediction of 1975 Haicheng earthquake by the Chinese seismologists raised considerable hope in this respect. However the failure to predict the 1976 Tangshan (China) earthquake showed that the above optimism was premature. This earthquake killed an estimated 250,000 to 750,000 people and ranks among the worst natural disasters in modern history. Thus while efforts must continue to develop means for reliable techniques of earthquake prediction, for the present improved stochastic hazard assessment procedures have to be relied upon.

The earthquake recurrence relation provide the return period of earthquakes having various magnitudes. The parameters for such relations are obtained of necessity by considering large source zones because that enables to assemble a resonable size of data base for such estimation. The Himalaya source zones which covers the plate boundary for about 2500 km length will be ruptured in several great earthquakes (M $\geq$ 8). Each of the ruptured sections may be about 250-300 km long Thus the combined analysis of this boundary will be biased towards estimating shorter return periods for great earthquakes than one may obtain for a particular plate (fault) segment. However, the palaeoseismologically obtained estimates of return periods over specific faults segments are typically several times shorter than what are obtained by seismological data.[7]

Thus the two oppositely acting errors in estimating the return periods may be compensatory to a certain extent and be a redeeming feature. It is however, desirable that basic research be conducted to investigate these aspects in order to establish the proper return periods Experiments that may be conducted are to use very long base interferometry to establish the rate of convergence between the Indian and the Eurasian plates and investigate paleoseismicity using carbon dating techniques. Combining these with earthquake dislocation estimates of convergence will enable to improve the estimation of the return periods of large earthquakes.

The potential for great earthquakes in a section of plate boundary is postulated to rise directly in proportion to the time elapsed since the last release of strain in a great earthquake in that section. This period is atleast several decades depending on the rate of convergence at that plate boundary. Thus the above process may be considered for use as a basis for a crude form of earthquake prediction. Although this still does not allow for a precise specification of the place, magnitude and time of the future earthquake, it helps in identifying areas of increased seismic potential. With a suitable procedure this information may be incorporated in the stochastic seismic hazard estimates. For example the maximum magnitude of the expected future earthquake in ruptured zones may be appropriately scaled down[5].

The probabilistic hazard maps are based on the Poisson model of earthquake occurrence which assumes that the earthquake process is stationary. However, since the earthquakes are caused by the strain accumulation due to plate motions, the occurrences of earthquakes in the same section of the boundary may show quasi-periodicity, the time period of which will be governed by the rate of strain accumulation, i.e., the rate of relative plate motion. Thus once a section of the plate ruptures in a great earthquake there will be a time gap before another great earthquake will rupture the same plate boundary segment again. This indicates that the assumption of stationarity involved in probabilistic hazard maps is unrealistic at least in respect of large earthquakes.

Qualitatively these ideas are represented in Figure 3 by haturing the ruptured zones of the great earthquakes. The most recently ruptured sections corresponding to the 1934 and 1950 great earthquakes will have lower seismic hazard in the next 50 years as compared to the values estimated on the basis of the model using stationary Poisson model for earthquake occurrence. The peak ground acceleration would be somewhere in between in the rupture sections of the 1897 and the 1905 great earthquakes. These qualitative conclusions can be refined using basic research on the lines suggested above to generate "Hybrid Seismic Hazard Maps" which use both stochastic and deterministic basis for preparations.

Although an organized program of study of the earthquakes processes and their effects is underway, it is no where at a level necessary to provide incisive answers to the many scientific questions for ensuring the safety of the populace at an optimum level and at an optimum cost in the near future. It is hoped that sufficient interest will be generated by this article to provide impetus for suitable intensification of the on going programs in the coming years.

Acknowledgements

This contribution has been supported by the Department of Earth Sciences, Roorkee University and by the Department of Science and Technology, Government of India. Tribhuvan University has granted leave to the second author.

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EARTHQUAKES, PREDICTION AND MITIGATION OF HAZARDS

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Introduction

The term Earthquake reminds us of the horror of buildings falling, deep cracking of the earth's surface, and all round devastation in the form of death to large number of people, damages to well prized structures and dislocation of electricity, water and communication.

Such earthquakes are small in number and generally take place in known places of instability located at different specified areas on the earth. A large earthquake in an earthquake prone area could occur once in 50-100 years. However, associated with such major earthquakes are a large number of smaller-felt or unfelt—earthquakes. These unfelt earthquakes could be occurring in millions every year and are known as micro-earthquakes.

The causes of these earthquakes have been attributed in early times to supernatural wrath of good, to the present theory of movement of plates. The present theory envisages that the earth's crust is composed of several semi-solid crustal plates floating over a viscous magmatic layer within the earth. These plates (upto 400 km thick) are supposed to float on it and their margins are in the process of constant movement with respect to each other e.g. subduction below the adjacent plate, or moving away from each other of the plates, allowing magma underneath to well up from in between, or sideways movement with respect of one another. These tend to disrupt the balance and stability of the crust and thus large faults or tectonic movements take place. These are mainly stick and slip movements between two sections of the earth creating large displacements which in turn triggers the earthquakes that we feel on the surface. Almost all the earthquakes are associated with mountain building and volcanic activity.

Another kind of earthquake is related to the eruption of volcanoes. These are due to eruption of hot magma and ashes through geological fissures or cracks within the earth. These also cause damage in the form of earthquakes, burning up habitations near about etc. These however are not as damaging or as horrific as the earthquakes caused by the fault movements on the crust.

The other kind of earthquake is man made, and is induced by the filling and emptying of water in large reservoirs of damsites. The weight of the water column and their variation during impounding, and percolation of water to weak fault zones underneath, cause fault movements, resulting in an earthquake. This causes earthquake of moderate nature

Earthquake Distribution

Major earthquakes caused by fault movement between two parts of the earth's surface, is generally known to occur in the globe along some well known seismic belts. This extends from west coastal region of South America, & Central America, Western & Mid-western areas of North America & Canada, Alaska, Aleutian islands, Japan, Phillipines, Indonesia, Papua & eastern Pacific islands, Malayasia, Andaman Nicobar Islands, Indo-Burma border, the Himalayas, Baluchistan, Iran, Turkey, Greece

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etc. This as also active along the mid Atlantic ridge all along the middle of the Atlantic ocean. These earthquakes are known to occur due to the subduction or distancing of two plate margins and are also associated with a number of volcanic activity. Earthquake epicentres of these belts range from 0-700 km in depth.

Earthquake Magnitude

The earthquakes are classified in Richter scale according to the magnitude of the energy released. A large earthquake say associated with a fault 1000 km long, extending 100 km downwards distorting the ground as far as 50 km on either side of the fault is equivalent to thousand nuclear explosions of 1 megaton of TNT. Richter magnitude is counted on a logarithmic Scale and ranges from -2 to 9. The scale is measured according to the amplitude of the seismograph signal at a distance compared to a standard amplitude in a Wood Anderson types of seismograph, and is expressed in logarithmic scale. An earthquake of Richter magnitude 6 is ten times stronger than that of magnitude 5, and 100 times to that of magnitude 4. Largest earthquake of its kind occurred in 1897 and 1950 in Assam, having magnitudes of 8.7 and 8.5 respectively, which devastated large areas and killed several tens of thousand of people.

Detection of Earthquakes

During an earthquake two kinds of elastic shock waves are propagated through the earth. One is Primary or 'P' wave, which tends to travel out with alternate compression and dilatation of the medium. The other tends to shear or distort the medium and is called the 'S' wave and has its movements perpendicular to the direction of propagation. 'P' wave involves change in volume and 'S' wave involves distortion without change in volume. Apart from these two types, surface waves on the ground are also generated and they are known as Love and Rayleigh waves.

P & S waves have distinct relationship in a medium. 'P' wave having a velocity 1.78 times the 'S' wave under normal conditions. These waves get reflected or refracted through the different interior layers of the earth such as solid mantle, fluid outer core, inner, core, and produces combinations of PP, PS, PSP, SSS and other types of wave propagations. The ability of a seismograph to detect these and that of a seismologist to decipher these signals and their time intervals, make it possible to locate the geographical position and depth of an earthquake, on the surface of the earth. Thus, shock wave arrivals of P & S waves at seismograph stations located at least at 3 or 4 different distant places on earth at different time intervals, enables one to locate the position of the earthquake epicentre. The magnitude, frequency and phase relations of these signals indicate the magnitude depth and fault movement pattern of the earthquake at its epicentral region.

Seismographs—Measurements of Signals

Early seismographs consisted of a mass loosely coupled to the earth by means of a pendulum or suspending it from a spring. When the ground moves, the mass tends to remain stationary because of inertia, and thus the displacement of the earth relative to it can be recorded. This motion is magnified electronically and a modern instrument can detect ground displacements as small as 0.1 nanometer and time differences accurate to a millisecond. The signals are recorded with a pen, usually over a sheet of paper wrapped around a drum. The drum rotates at a fixed rate and the pen moves sideways, as the drum rotates. Present seismographs have higher sensitivity of recording earthquakes. Even magnitude 1 earthquake which could be termed as a microearthquake, could be detected at a distance of 100 km. Presently, instruments have been developed to automatically record several microearthquakes in real time, in an unmanned station, in tapes, running over a period of several weeks.

Recording of these large number of microearthquakes enabled one to study statistically the mechanism of earth's interior much more precisely during an earthquake. With satellite link or telemetry, data from a large number of distant recording stations could be read at one central station without manning the stations individually.

Distinction between Earthquakes and Underground Explosions

Earthquakes are generally caused by the sudden release of strain energy accumulated over tens or hundreds of years, through tear or fault movements, and thus two earth masses move with respect to each other along the fault plane. An earthquake is thus associated with a mechanical couple (a pair of forces acting in parallel but in opposite directions). Seismographs placed in the vicinity will record different ground motions in the four quadrants related to the fault plane i.e. two will record compressions and the other two will record initial dilatation of the medium. Through these recordings over an area, the ground movements due to a fault could be determined from the signals of a network of seismographs. This is typical of almost all earthquakes.

In the case of a nuclear explosion, the energy radiating outward from a single point should cause initial compression everywhere at all seismograph stations. Uncertainity arises however, if stations are not close enough or intervened by oceans or other viscous media The signal of initial compression everywhere is thereby vitiated.

Prediction of Earthquakes

Many methods have so far been used to try to predict earthquakes. This ranged from systematic physical and geological studies, to observations of unusual animal behaviour.

China, Japan, USA, USSR have so far developed some methods which more or less correleated with the occurrence of an earthquake in space and time. Some of the entities that are known to be precursor signals are measured accurately and systematically by several scientific agencies. In India too, National Geophysical Research Institute at Hyderabad ; Central Water & Power Research Station at Pune; Bhaba Atomic Research Centre, Bombay ; Geological Survey of India, Calcutta ; North Eastern Council, Shillong ; Indian Meteorological Dept., Delhi ; Roorkee University, Roorkee ; Wadia Institute of Himalayan Geology, Dehra Dun ; RRL, Jorhat and Survey of India, Dehra Dun ; are some of the organisations involved in this endeavour.

The signals that are important tools for the prediction of an earthquake could be explained by a theory of dilatancy.

The theory suggests that the earthquake is manifest through some earlier physical changes within the ground due to the change in stress caused by the plate movements. In an rock mass, when the stress increases, cracks are first developed, which subsequently dilates the entire region and allows the groundwater to flow in. Further increase in stress, allows the cracks to fall in line of several fault planes, and finally, with further increase in stress, the movement of rock masses take place along these fault planes.

The assumption of this theory, enabled one to explain the various changes in the signals of recorded microearthquakes, which occur in large numbers before and after a major earthquake. Other signals, such as change in ground electrical resistivity, change in the velocity of 'P' wave of the ground etc., in an area also could be explained by the dilatancy theory.

The signals obtained for prediction could be both long term in nature (i.e. one to ten years) or short term in nature (hours to weeks). In the following lines a few well known changes in signals are listed which are normally measured and used for the prediction of an earthquake.

(1) Long term creeping abnormal changes in the surface elevations, or locational positions, in the approximate area to be affected, are indicators of a large earthquake to come. For this purpose systematic elevation and location measurements over years need to be taken to pinpoint the area to be affected and predict the approximate time space and magnitude of the major earthquake to come.

(2) Measurement of P & S wave velocities in the type area could signal onset of an earthquake. It is stated that the 'P' wave velocity gets reduced in the dilatant area and then tends to get to the normal value after a long period The expected earthquake is stated to occur at the point of time when the wave velocity attains normality from the reduced value. The reduction of P wave velocity in the dilatant region could well be upto 30%.

The time period of this change is proportional to the magnitude of the earthquake predicted.

(3) The function log $N = a - bM$, where N is the number of earthquakes of magnitude M during a fixed period (say a month or week) and a & b are constants, is applicable to a dilatant area. The value of the constant 'b' has to be changed to fit in the equation, and becomes very low before an impending earthquake. Monitoring of such 'b' values of large number of microearthquakes and moderate earthquakes, in an area, indicate this change, Earthquakes are generally predicted at the time when 'b' value is the lowest.

(4) Return period of a major earthquake can be calculated statistically for an area to arrive at the possible time and place of occurrence of a major earthquake.

The short term predictions techniques covering a smaller area are the following.

(5) Deep electrical resistivity of the ground in an area changes over a period of days or weeks by as much as 5 to 50% before an earthquake. Generally, the resistivity values fall over a period and the earthquake takes place when it is at the lowest value. It has also been found that at some places the exactly opposite phenomena of 'rise' in resistivity has been correlated with the onset of an earthquake. The magnitude of the earthquake is dependent on the time period of the fall of the resistivity to the minimum and is directly proportional to it. The phenomenon is applicable in areas upto 100 km away from the earthquake epicentre.

(6) The Radon gas content in ground water in the type area increases rapidly a few days or hours before the onset of an earthquake. The increase has been found to be 100 to 300% of normal value and has been correlated to an earthquake of magnitude 6, occurring 300 km away, as was recorded recently at Shillong.

(7) Rise in water level in wells and increase in spring discharge in the area, have been correlated with the onset of an earthquake of moderate intensity.

(8) Finally, and not the least the abnormal behaviour of animals e.g. fish, dogs etc. and

earth living creatures e.g. snakes, frogs etc., are good indicators of the onset of a large earthquake. This has been successfully detected and used by the Chinese in predicting an earthquake.

So much for the predictions. Some predictions take years to materialise whereas some predictions can be made few hours before. So far correlative researches have been made but very few actual predictions have been seriously utilised. The location of such earthquakes are also known to be predicted quite accurately The great Haicheng Earthquake of 1976 in China was well predicted in advance to enable authorities to take steps to evacuate the entire city and let people live in tents. The earthquake took place as predicted in time and space saving lives of thousands. However, another major earthquake within a short time could not be predicted in advance in China. It requires a large network of observation stations and people working in them. It is extremely expensive and time consuming, and requires correct and integrated interpretation.

Problems of a Prediction

There is an inherent problem arising out of the predictions made by different agencies. It is necessary to integrate and correlate all the data at one point to arrive at a proper conclusion and that too to be carefully scrutinised and revised in view of the socio-economic fall out. During February, 1980, some scientists in Assam predicted an earthquake in the North-Eastern Region of India and it obtained newspaper coverage. Busloads of people fled Nagaland in panic and on the alleged fateful day very few vehicles plied on the roads of Shillong and people lived indoors. This is the outcome of such a half baked prediction made by individual scientists and newspapers flashing them for a scoop. Such kind of prediction tend to be disbelieved later. In fact, it has long term implecations as well. If an earthquake of major kind is predicted in an area, the following things can happen.

(1) People who have means would like to flee the area.

(2) Longterm big projects such as bridges, power stations, factories, engineering structures, town planning etc. would not be proposed there by Industry or Government.

(3) Insurance cover for natural calamities in these areas for large engineering structures or projects will be high.

(4) Price of properties in the area will fall.

All these lend importance to the establishment of a single agency of scientists through which such predictions should be made—after integrating the information from different agencies and network.

Secondly, some other agency would be needed to keep, assistance and relief material ready in the case of an earthquake. These should oversee arrangements for water supply, restoration of electricity & telephones, firefighting, medical supplies, maintenance of road and rail communications etc. This agency should also look into possible precautions to be taken generally by the people for the mitigation of damage to property and life in case of an earthquake of disasterous magnitude takes place. They should educate people of the 'do's and 'dont's in case of an emergency.

Earthquake Control & Mitigation of Disaster

Once an area is known to be earthquake prone & the faults likely to be activated are identified, it may be possible to reduce the damage of a predicted earthquake by lubricating the faults with pumped water and let the strain energy be released through several small magnitude earthquakes. This had been tried in the Rangely Oil Fields in Colorado using boreholes to pump water in and a very good correlation has been obtained with the quantity of fluid injected and earthquake activity. However, these operations are still in experimental stage and involve lot of study and expenses. The Reservoir Induced earthquakes are caused by similar nature of water seepage in vulnerable faults underneath. To mitigate the damage caused by earthquakes—which is most likely to be more in cities or inhabited areas, planning of superstructures, bridges, buildings etc., needs to be made with appropriate knowledge of ground movements, frequency of likely shockwaves, geological condition of the ground etc. Tall buildings need to be protected by not allowing it to vibrate resonantly with the earthquake movement prevalent in the area. .They have to be strengthened against soil or rock condition of the area. Smaller buildings with appropriate structures and brick & mortar, are more suited for such earthquake prone areas.

The Indian Scene

Seismicity and earthquake prediction studies are being carried out in India systematically during the last decade especially in the N-E states of India. In the North East, the Indian plate is subducting towards east & north below the Eurasian plate causing large number of earthquakes in this region—particularly in the Burma border. In the N-W Kumaon region & Himalayas in general, the Indian plate is either subducting northward or having an attrition with the Eurasian plate making the lower Himalayas a region of earthquake occurrences. Prediction studies have been taken up in these areas as well. Geological Survey of India, Indian Meteorological Dept., National Geophysical Research Institute, Wadia Institute of Himalayan Geology, Roorkee University and Survey of India are carrying out research and field programmes directed to this subject. In India, the most seismically active regions are the Himalayas, Indo-Burma Border, and Andaman & Nicobar Islands. Large Earthquakes of the order of 8.7 & 8.5 took place in the North Eastern India during 1897 and 1950 creating havoc and innumerable loss of lives. Lesser intensity earthquakes rock frequently the N-E region even now. The latest being near the Manipur-Burma border in August'88 and Bihar-Nepal border immediately after. No prediction programme by the government has yet been taken up even though observations and successful correlations to earthquake occurrences by different agencies are still on. Mitigation of hazards by planning earthquake resistant buildings has been taken up on a research basis by the Earthquake Engineering Department of Roorkee University. Some planning has been made to record the ground motion in the N-E region for establishment of engineering structures. The North-Eastern Council of the N-E region is now making efforts to bring an integrated study of the status of seismicity, prediction programme and mitigation of hazards.

The reservoir induced earthquakes are being studied especially by CWPRS at Pune, NGRI, and the Bhaba Atomic Research Centre, bringing out knowledge of the mechanism of these kinds of earthquakes and means to avoid them. Instances of such earthquakes with damage are known at Koyna Damsite of Pune, Angul area in Orissa and Bahsa damsite near Bombay. The efforts are welcome, but a frontline thrust is necessary from the Government not only to educate people on this natural calamity but also to fund large scale programmes on seismicity studies and prediction.

Conclusion

Areas where maximum attention should be given are :

(a) To increase the knowledge and location of the vulnerable areas of earthquakes in the globe through constant monitoring and study of the millions of microearthquakes occurring without our feeling them.

(b) To know the nature of ground acceleration in such areas and to adapt establishment of earthquake resistant structures to withstand major earthquakes.

(c) To implement organisational and administrative discipline in making earthquake proof buildings, impart adequate knowledge to the people to act against such an emergency, and to take appropriate precautions against consequent damages.

(d) As far as the prediction is concerned, a concerted and integrated observational effort should be taken up by the Government in the vulnerable areas, through a network of stations. [ ]

FORECASTING OF EARTHQUAKES

H. S. VIRK*

Earthquake forecasting has not achieved the same degree of success and confidence level as in case of weather forecasting. However, though we are still far from developing the capability to routinely issue intermediate and short-term earthquake predictions, significant advances have been made in understanding the physical processes of earthquake generation, and temporal and spatial recurrence patterns of earthquakes in many parts of the globe. The seismic zones of the earth have been delineated quite accurately. It is also encouraging to note that during the last two decades, more than a dozen earthquake precursors which hold out considerable promise, have been identified Our own programme is based on radon anomalies as a precursor. Recording stations are set up at Amritsar, Thein Dam and Palampur (Kangra valley) under a project sponsored by Department of Science and Technology (DST) in 1988. There is reason to be optimistic about increasing the accuracy of earthquake forecasting in near future.

Introduction

Earthquakes constitute one of the worst natural calamities on the earth. It is estimated that from the beginnings of recorded history to the present about 75 million human lives might have been lost to earthquakes Earthquake related deaths average over 15,000 per year, and in 1976 alone about 2 lacs people were killed in China, Guatemala, Phillipines and in other parts of the world. The damage to property runs into billions of rupees. Every year, on an average, about 1000 earthquakes of magnitude greater than 5 on Richter scale,

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several in the 6-8 magnitude and one of magnitude greater than 8 may occur, with a super-destructive earthquake occurring somewhere on earth once every three years. In India, where 55% of the land area falls under active seismic zones, considerable destruction was caused by the earthquakes of Kutch (1819), Shillong (1897), Kangra (1905), Bihar-Nepal (1934), Assam (1956), Koyna (1967) and Bihar-Nepal (1988). Fortunately, most of the earthquakes in India occurred in sparsely populated areas. With a growing population, damage to life and property is likely to increase, unless success in earthquake forecasting is achieved in near future.

Causes of an Earthquake

Earthquake are often attributed to different types of seismic waves generated at the earthquake focus. The waves that arrive at a recording station first are called P or primary waves with velocities of the order of 5.5 to 8 km/s. These waves are similar in nature to sound waves. The next to follow are S or secondary waves. They are shear or transverse waves, with velocities of the order of 3.3 to 4.8 km/s. Both these waves propagate radially in all directions from the focus of earthquake. In addition, there are two types of surface waves, viz. Rayleigh and Love waves, which are the slowest to arrive.

There are two types of earthquakes, volcanic and tectonic. The former are the effect of volcanoes and are frequent in volcano-prone areas like Japan and Kampuchea. But most of the earthquakes are tectonic in nature. According to the theory of plate tectonics, our lithosphere is made up of six major and six small plates floating on Asthenosphere. When these plates interact by colliding, going apart or sliding against each other, some stresses are built up resulting in the storage of energy. Afterwards when this energy is released, earthquake occurs associated with fracturing, faulting or other types of land deformations. According to this hypothesis, our Indian plate is moving 5 cm/year in N-E direction. It encounters the adjacent plates in the Burma region in the east, the Himalayan foothills in the north and Suleman ranges of Pakistan in the west. Great earthquakes in Shillong (1897), Kangra (1905), Bihar-Nepal (1934) and Assam (1950) have occurred on the northern boundary of the Indian plate which is underthrusting the Eurasian plate. The rise of Himalayan belt is also explained on its basis.

Earthquake Precursors

Over the past two decades, a number of precursors have been identified. A precursor is a phenomenon which takes place usually prior to the occurrence of an earthquake. These precursors are land deformation, tilt and strain, animal behaviour, foreshocks, anomalous seismicity, b-value, seismic velocities, geomagnetism, resistivity, randon anomaly, groundwater level, oil flow, etc. All these properties show some abnormal behaviour prior to an earthquake.

Though seismic techniques have been commonly employed for the study of earthquakes, now a days there is much tendency to shift emphasis on other precursors also. In China, a group of earthquake researchers have carried out extensive surveys on animal behaviour all over the country by consulting the caretakers of bird sanctuaries and zoos. In all cases, reports indicate of something, making the animals upset prior to the destructive earthquake. Animals through their extra-sensitive perceptions are much more capable than humans of perceiving certain kinds of geophysical stimuli. Laboratory experiments on pigeons, bats, rats, fish and kangaroos have confirmed that they show strange reaction of fear and stress before an earthquake.

It has been observed that before severe earthquake pet animals (dogs) start biting their masters ; horses and cows break the tether and run like wild animals, the fish start jumping out of water ; rats, snakes and other reptiles crawl out of their holes. Abnormal animal behaviour may be due to some sort of electromagnetic radiations, some gases, or ground motions.

A key element in the earthquake prediction programs all over the world is the detailed measurement of temporal and spatial variation of crustal strain, using geodesy. Geodetic measurements provide the most accurate method to observe crustal movements. Many studies, particularly in Japan and the U.S.A. indicate that unusual crustal movements have preceded some earthquakes of $M=6.5$ or greater. Ground deformation can be measured by an array of tiltmeters However, the experience gained by U.S.G.S. in California indicates that tiltmeters are sensitive to spurious signals due to topsoil movements caused by rain, temperature and pressure fluctuations.

Many case histories of electrical resistivity variations (10-15% decrease) associated with earthquakes have been reported from the U.S.S.R., Japan and China. Another, geo-electric phenomenon which is often reported as an earthquake precursor is anomalous changes in telluric currents. Rikitake documents numerous geomagnetic variations which are reported to have occurred before major earthquakes, especially in Japan, the most extra-ordinary of which being the one about a huge horse-shoe magnet having lost its magnetism just before an earthquake in Tokyo in 1855.

Japanese seismologists predicted as early as in 1920 that the velocity of seismic waves passing through the focal region of an impending large earthquake could be modified due to strain accumulation. Russians were the first to make use of this precursor and to observe anomalous changes in the ratio of P-wave to S-wave velocities. The excitement reached a peak in U.S.A. when Aggarwal *et al.* (1973) predicted a magnitude 3 earthquake in the Blue Mountain Lake area of New York state. After this prediction, there was a general optimism among the seismologists that here at least was a promising precursor for earthquake prediction. Alas, this excitement was short-lived as data collected along the San Andreas fault in California showed that velocity anomalies are conspicuous by their absence.

The slope of the line relating earthquake magnitude and logarithm of the number of earthquakes of that magnitude is called b-value and is directly related to the state of stress of the earthquake source region, the higher the stress the lower the b-value. There are numerous attempts to look for temporal variations in b-values as a tool for earthquake prediction.

During the past two decades efforts have been made to measure anomalous emanations of helium, radon, hydrogen, CO_2, and other gases in earthquake-prone regions of the world. Among the terrestrial gases, radon has been the most favourite of earthquake predictors. Geochemical anomalies can provide life-saving short-term earthquake predictions.

Monitoring of foreshocks, rise in well water, flow rate of oil wells and temperature fluctuations are some of the other useful precursors for forecasting earthquakes. The most important problem with all these precursors is to distinguish signal from noise. A single precursor may not be helpful, the prediction programme strategy must involve an integral approach spread over a number of stations.

Earthquake Forecasting

If anyone poses the question : "Would it be possible to forecast earthquakes one day ?" The answer is "yes". What is an appropriate strategy for earthquake prediction in India ? Immediately after the occurrence of Bihar-Nepal earthquake in 1988, a national seminar was organised at I.I.T. Kanpur in December, 1988 to take stock of the whole situation. Most of the papers presented at the seminar did post-mortem of the event suggesting some remedies based on earthquake engineering. Forecasting of earthquakes formed the theme of just two papers out of 50 presented at the national seminar. Once the seminar is over, there is no follow up programme till the next major earthquake occurs Department of Science and Technology, Govt. of India is seized of the problem after intervention of our Prime Minister and earthquake forecasting may be considered as one of the Thrust area programmes or better as one of Sam Pitroda's Technology Missions in near future.

When we take into consideration the fact that earthquake prediction as a science is less than a quarter of century old, our achievements have not been trivial. Our most significant advances have been in the area of identifying earthquake-prone regions, understanding physical processes related to earthquakes, and most important of all making accurate measurements of numerous earthquake-related phenomena. Even though precursory phenomena seem to be elusive for forecasting of earthquakes and saving lives (except in Haicheng earthquake in China), there should be no reason for pessimism. Rikitake (1982) has recognised some pattern in the occurrence of earthquakes on the basis of precursor time-magnitude curve (Fig. 1).

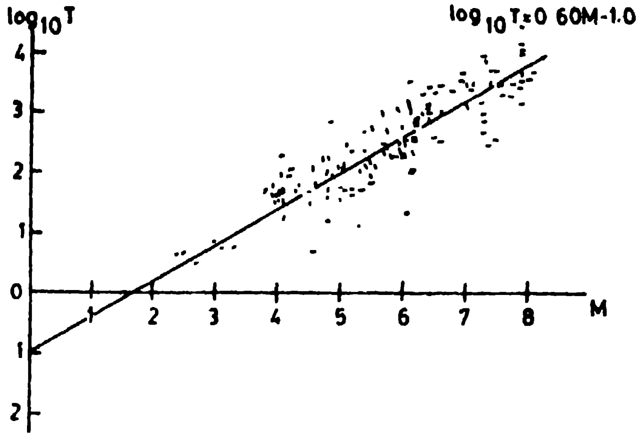

Fig. 1. Relationship between logarithmic precursor time T in days and magnitude M of earthquakes.

Indian Scenario

India has been divided into five seismic zones. The highest danger from earthquakes lies in zone V which includes parts of Kashmir, Himachal Pradesh, East U.P. and Bihar hills, North-Eastern Indian states, Andaman Islands and Rann of Kutch Rest of northern India foothills and adjoining plains including Delhi lie in zone IV. Parts of Rajasthan, Madhya Pradesh and Southern peninsula are relatively free from earthquakes and have been placed in zone I. This map serves as a rough guide for seismologists, earthquake engineers and planners to choose proper sites for important projects like dams and nuclear plants.

In India, the occurrence of Koyna earthquake in 1967 attracted the attention of seismologists and engineers throughout the world, as it occurred in the most stable part of the Indian shield (zone I). The Koyna area began to experience minor earth tremors with the filling up of the reservoir in 1964. To study these, a network of observatories was established around the Koyna dam and accelerographs were also installed within the dam. The Indian government set up a Koyna Tremors Committee in 1968 and with the help of a UNESCO team in 1969, a detailed report about the causes of Koyna earthquake was published. The report does not mention any direct correlation between the filling up of the reservoir and the seismicity of the dam. Some other dams like Nagarjun Sagar, Hirakud, Ukai and Idduki have shown temporary increase in tremors while others like Bhakra, Pong, Pandoh and Ram Ganga have so far not indicated any increase in seismic activity even when located in seismic zones.

During the last 100 years, four great earthquakes ($M \geq 8.0$) have occurred in the Himalayan seismic belt in 1897 (Shillong), 1905 (Kangra), 1934 (Bihar-Nepal) and 1950 (Assam) causing huge loss of life and property over wide area. Micro-earthquake seismicity is very high around Dharamsala H.P.) and Shillong. In view of higher seismicity in western Himalayas and north-east India, greater attention is being paid through the establishment of closer network of seismological stations under a colloborative programme between Department of Earthquake Engineering, Roorkee University and CALTECH, U.S.A. Strong motion accelerographs have been installed at a number of places in Punjab and H P and plans are afoot for deployment of 3 telemetred arrays of 24 channels in the grid 32°-33°N and 75°-78°E (100×300 km^2) around the so-called H.P. seismic gap demarcated by Srivastava and Chaudhury (1978).

Forecast of 'Impending' Earthquakes

A simple and beautiful concept of 'seismic gap' is being exploited for forecasting of impending earthquakes in India. Identification of seismic gaps (segments of plate boundaries that have exhibited long periods of seismic quiescence are known as seismic gaps) has proved to be an important tool for long term earthquake predictions.

Khattri and Wyss (1978) have predicted and delineated the Assam seismic gap. Arun Bapat (1986) also delineated a 'seismic gap' in Assam area defined by 26.5°-27.5°N and 94°-95°E where an earthquake of magnitude 7-7.5 was forecast within 300-400 days as calculated from June 15, 1986. The forecast has not come true. North-east India is a very complex region and a number of seismic gaps can be delineated The different regions for a future great earthquake have been identified as follows :

(i) Shillong Plateau (P wave anomaly).
(ii) South-east of Shillong near Cachar area.
(iii) Between Shillong (1897) and Assam (1950) earthquakes.
(iv) Arakon Yoma.
(v) Kopili lineament.

Microseismicity is still being observed at a very high level around Shillong. A telemetry system has been deployed under the All India DST Coordinated Project on Himalayan Seismicity. Central Seismological Observatory, Shillong has the best facilities in India for recording of future events.

The most destructive earthquake in H.P. occurred at Kangra in April, 1905 where 20,000 people were killed. It measured more than 8 on Richter scale. In 1945,*Chamba was rocked. In recent history, moderate size earthquakes occurred on 19th January, 1975 in Kinnaur and on 26th April, 1986 at Dharamsala.

In the Himachal Pradesh, the areas for which future earthquakes of great intensity can be expected are as follows :

(i) Dharamsala (where the Kangra earthquake occurred).

(ii) Seismic gap 32°-33°N and 76°-77°E.

(iii) Kinnaur region.

The only country to successfully forecast an earthquake is China. In 1975, Haicheng earthquake was predicted by a judicious synthesis of a number of precursors and it raised great expectations for future. Unfortunately, in 1976, Tangshan earthquake in China took a heavy toll of human lives and could not be predicted. The real test case will be the Parkfield earthquake in California which is predicted to occur before 1993. This site on San Andreas fault is being monitored by using the most sophisticated equipment available in the world.

Radon Monitoring for Earthquake Prediction at Amritsar

The release of radon from natural minerals or soil as the decay product of uranium present in traces in the crustal rocks has more recently been used as a possible tool for earthquake prediction. Anomalous radon changes were observed at some water wells and springs located along certain fault zones in China and Russia before earthquakes. In India, Atomic Minerals Division, Hyderabad did some pioneering work in North-Eastern region and Assam plateau. The only other station where radon has been continuously monitored since 1984 and its correlation established with some of earthquakes that occurred in the region is located at Guru Nanak Dev University, Amritsar.

Three different techniques have been perfected for recording of radon anomalies in soil and water. These are radon emanometry,

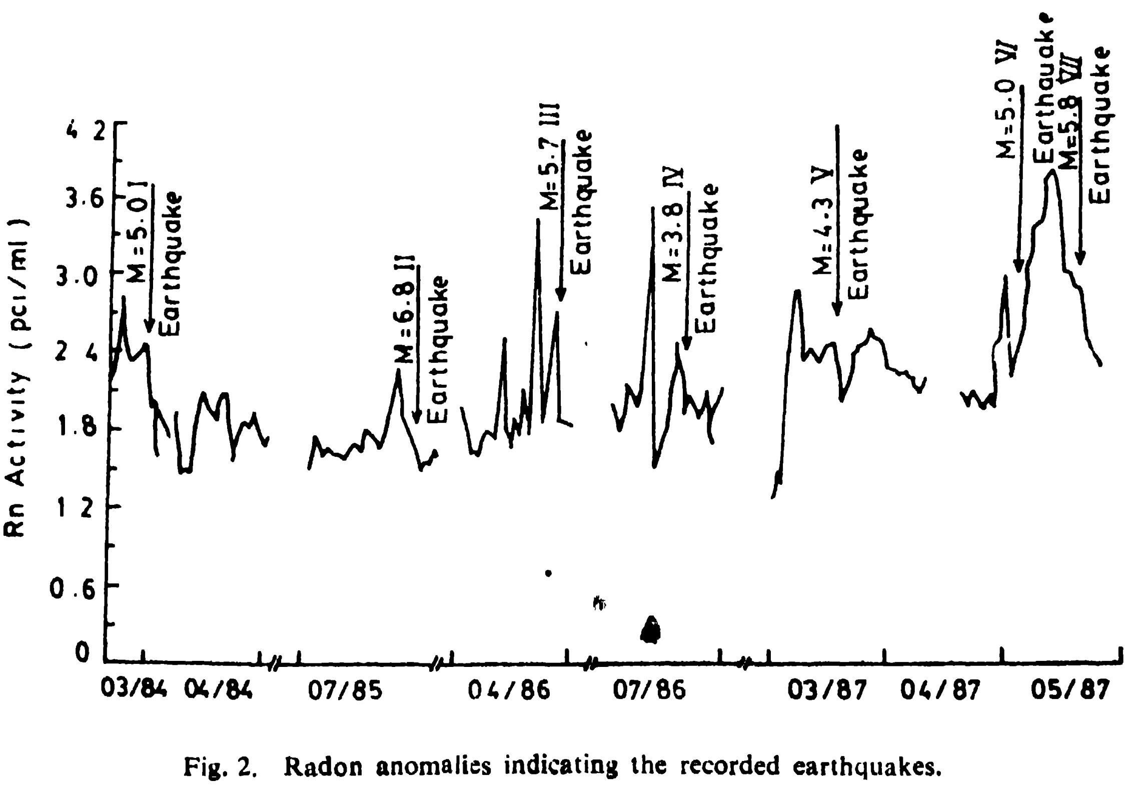

Fig. 2. Radon anomalies indicating the recorded earthquakes.

alpha-meter or logger and plastic track detectors (LR-115 or CR-39). The detectors are calibrated by using standard $RaCl_2$ solution.

Radon emission is very sensitive to environmental fluctuations and the correlation is extremely useful for discriminating the genuine signal from noise. As our station is located near Kangra valley, it has been a useful exercise to correlate some of the radon anomalies with earthquakes (Fig. 2). We recorded radon anomalies corresponding to Dharamsala earthquake of April 26, 1986. Even signatures of Hindu Kush earthquake (May, 1987) were recorded at Amritsar, 600 km away from the epicentre. To be useful as a precursor in forecasting earthquakes, continuous monitoring of radon in soil gas and well water at several sites, in a grid pattern, is necessary. Radon recording stations have been set up during July, 1989 at Palampur (H.P.) and Thein Dam. It is also proposed to study changes in resistivity at all the recording stations. Concerted efforts will have to be made if we want to succeed in forecasting of earthquakes before the end of 20th century

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THE FLOOD HAZARD

S. MOOKERJEE*

I. Generalities : Descriptive, Historical and Humanistic

Even if the Jurassic geosynclines, locked up between continents, did not leave much room for sea water, the memory of an Ice Age followed by extensive floods by the melting of Pleistocene Ice sheets, over more than half of North America and Eurasia, got embedded into the mind of man who was already present on Earth about this time. In fact, the legend of a Great Flood has been woven into the mythology of most religions, indicative of this experience. Be it Noah's Ark rescuing mankind (and also the animal kingdom) from a great deluge or be that the protector—God Anantha Shayanam Vishnu who saved man from Pralaya—Payodhi in time immemorial.

Flood has been a common experience of man ever since his early collective life. Not that floods have come every year or everywhere, but there has been widely dispersed areas on earth where the flood hazard has created problems for man's habitation and livelihood in pre-historic period as well as all through recorded history. Only a date or year-wise account is not available except for the past 100 years or so. The longest hydrological record in existence for a period of about a thousand years, is from Egypt. In fact, data on flood 'stages' for the Nile near Cairo extend back to 622 A. D.

The present age is given to Information Sciences and the novelties of investigative journalism. An International Conference on Water '89 has been scheduled to be organised in Bangkok, Thailand on 14-17 December 1989. The theme is Water Decade and Beyond, supported by UNESCO, ESCAP, UNDP, WHO, UNEP, UNICEF and similar international and UN agencies. Though floods are not on the agenda of this conference, but it is expected that no discussion on water availability can be held without consideration of an excess flood water, even if locally or seasonally. We had the International Geophysical Year in the late fifties and then the International Hydrological Decade ; and also earlier the functioning of International Commission on the Danube and the Mekong, Reports of the Mississippi River Commission and of the Tennessee Valley Authority, the Damodar Valley Corporation—all concerned with problems of flooding in riverine lands. Then an entire day's deliberation was devoted to the "Pacific Century" in the recently concluded International Geographical Congress at Sydney, Australia (August, 1988) where the grim prospects of inundation of low-lying coastal areas and of islands in and around the Pacific in the coming century werea nalysed in great details. The immediate cause of that inundation is obviously the eustatic change of sea level by melting ice because of rising global temperatures through what is called, somewhat euphemistically as the Greenhouse Effect.

Near at home, the common man has to read a typical journalistic account of a recent flood as below :

"Flash floods swept away five people in Palamu district of Bihar and swollen rivers submerged vast areas, affecting thousands of people in Katihar and Sitamarhi. Official sources said several overflowing rivers inundated six blocks in Katihar and Sitamarhi, affecting over 114,000 people, besides damaging standing crops worth about Rs. 22 lakhs". ...Again, "In Laharighat in Assam, the Chief Minister,... said that the swollen Brahmaputra washed away 21 villages—10 at Bhuragaon, 9 at Laharighat and 2 in Mayang circles in Nagaon district—rendering 1300 families homeless and submerging 500 acres" (The Statesman, Calcutta, July 22, 1989, p.1.).

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Also, from the same newspaper of same day, one comes to know that "Army assistance was sought today (i.e., 21st July, 1989) as the flood situation worsened in Bihar, while floods caused by heavy rain and swollen rivers spread to four eastern districts in Uttar Pradesh, affecting 2000 villages".

Within the past fifty years the most devastating flood in Bengal (then undivided) was of the River Damodar in about July 1943, when railway tracks of the then B. N. R. got washed away and railway bridges completely collapsed—causing a total break-down of essential military supplies to the eastern theatre of War. Since this affected the War Effort in general and disrupted the allied forces' strategic operations against the Japanese, a very serious thought was given to the disaster. A major reason for the creation of India's Damodar Valley Corporation (D.V.C.) on the lines of America's Tennesse Valley Authority (T.V.A.) in the post-war period, to combat, inter-alia, the occurrence of frequent and heavy floods in the Bihar-Bengal area, was this flood of July 1943 and there recommendations of an Enquiry Committee set up soon after. Professor M. N. Saha, the doyen of Indian Physicists who always took an active part in nation building enterprises, evinced a keen interest in River Valley development and the need for a systematic river training programme. In fact, he was a great pioneer in developing studies in River Physics in this country and encouraged some of his students to work on rivers and to publish results of their work in the pages of *'Science and Culture'* of those days. Professor Saha's pleadings and writings went a long way in convincing the authorities of Government to plan for multipurpose River Valley projects beginning with the Damodar—India's river of sorrow like Hwang Ho of China. Mention must also be made of Professor P. C. Mahalanabis who, as Professor of Physics in Presidency College, also held charge of Calcutta's Meteorological Observatory, in an ex-officio capacity, made his first contribution to Statistics, while investigating the frequency of Orissa Floods in the early thirties.

According to a recent estimate, India has lost Rs. 768 crores, over the past 25 years because of floods. In 1983 alone 36 million hectares were devastated and more than 2,000 of the 50 million victims died. During the 150-year period 21 floods affected West Bengal with an average recurrence period of 7 years. But since 1953 this recurrence period seems to have been increased to 3 years only. The recent major floods listed by S. P. Chatterjee[8] in his article on "Floods in West Bengal" were : Teesta 1950, Mahanadi 1951, Mahanadi-Teesta-Damodar 1955, Central districts of West Bengal, September 1956. The present generation of readers will, however, list the floods of 1978 to be the most devastating in West Bengal in living memory.

It should be added here that even highly developed countries are also not immune from floods, inspite of their technological supremacy. In U.S.A., for example, floods cause damages amounting to 100 million dollars every year, in addition to a toll of human lives.

II. Technicalities : Definition, Terminology, Causes, Occurrence, Magnitude and frequency

Definition and Causes :

A flood is considered to be an unusually high stage of the river—when the stream channel gets filled and above which it overflows the banks. The valley is then flooded. Webster defines 'Flood' as a great flow of water—"especially, a body of water, rising, swelling and overflowing land not usually thus covered ; a diluge, a freshet, an inundation". An arbitrary elevation is established for "flood stage".

A flood, according to Jarvis, is a relatively high flow as measured by gage height or discharge rate. Gage readings indicate levels of water surface at measuring stations. Distinction between normal discharge and flood flow is determined by the usual discharge habits of the stream. Floods occur more frequently in certain seasons. However, the greatest flood may occur, when least expected. In North India (i.e. the Gangetic Plain), most of the floods have occurred in the autumn season, that is after monsoon rains, in September/October or even November. Frequency of floods (as also the magnitude) may be estimated by empirical formula, or by statistical methods or by the Unit Hydrograph method. The only known, dependable method is the Unit Hydrograph method—for which a continuous precipitation and run-off record is required. According to Leopold, Wolman and Miller[4], "Floods are usually considered climatically controlled events of geomorphic significance—The occurrence of floods is studied as a probability problem, and knowledge of the probability of floods is needed for a variety of engineering and economic reasons". A flood is due to surface run-off and may result from (i) an intense rainfall, (ii) melting of snow, (iii) melting of snow combined with rain. A combination of several causes is also possible. According to Jarvis[2], flood flows are direct or indirect result of precipitation, even though the run-off may be delayed or modified by freezing thawing, surface inequalities or indentations, interruptions on vegetal cover or through infiltration. Owing to differences in infiltration resulting from variations in initial soil moisture and the effects of land use, tillage, vegetal cover and leaf mold or forest litter, and owing to differences in geological structure, a given rainfall may produce only a moderate rise in the streams of one area and flood conditions in another area.

Occurrence, Frequency and Magnitude etc. :

"In contrast with records of annual or monthly values of run-off, flood occurrences may be treated as random events"[4]. If in a period of 30 years the largest flood recorded was of a certain size, it is possible that the next 30 years will also contain a flood of equal magnitude.

Several procedures are used for computation of flood frequency. "Thus, a flood having a recurrence interval of 10 years is one that a 10% chance of recurring in any single year. Such a flood or even one so large that it would not be expected more than once in a hundred years, might occur next year". Thus the recurrence interval is not a "forecast". The flow potential of basins of 300 square miles has been depicted on maps for the United States "A 10-year flood (one having a recurrence interval of 10 years) is not a great or catastrophic flood but one of moderate size".

There is a widespread belief that floods are increasing in magnitude and frequency (in the U. S.). Discharge data of recent floods would point to this conclusion, which, however, is not wholly justified... Flood records are constantly growing longer. Flood stages, if not discharges, are, however, increasing, in most rivers. All levees and flood walls that are built along rivers to protect property from overflow raise the stage upstream, and, by reducing the volume of channel storage, tend to increase both stage and discharge at all points upstream. Every bridge or dam built across a stream and every structure built upon the banks, constitutes an encroachment upon the streams that tends to raise the stage of water at all points upstream In populous areas these encroachments are numerous, with resultant rises surprisingly large.

Whether flood discharges are increasing can be answered, based on the following questions : (1) Are storms increasing ? No such evidence of climatic change. (2) Are physical characteristics of the drainage basin changing ? This is not so simple for an answer. Changes in land use do affect infiltration capacity and, therefore, rate of surface run-off. In basins that are being rapidly urbanised, flood flows are unquestionably being increased. Every new home that is being built, with pavements, driveways and side-walks reduce the infiltration capacity to zero. Storm sewers collect and convey this water to stream channels, resulting in increasing peakflows.

The Design Flood : No structure of importance, in or adjacent to a river, should be built with the consideration to the damage it may cause, or be subjected to, in time of flood. The destructive powers of a raging torrent are frightfully tremendous. Dams must have sufficient spill-way capacity and protection against "scour at the toe" ; enbankments must be high enough not to be over-topped ; reservoirs must have the required capacity ; bridges must have the needed water-way etc. The maximum flood that any such structure can safely pass is called the design flood : If a flood of a given magnitude occur with an average frequency of once in 100 years, there is a one per cent chance or 1 chance in 100, that such a flood will occur during any one year ; a flood whose magnitude is likely to be exceeded on an average of once every 25 years is a 4 per cent chance flood. An average person considers a flood having a "frequency of once in 100 years" as carrying no threat but likely to occur only after a lapse of 100 years. For any design flood, what is more important is the chance or probability of the flood and not its magnitude. Hydrologic systems are sometimes impacted by extreme events, such as severe storms, floods and droughts. The magnitude of an extreme event is inversely related to its frequency of occurrence, very severe events occurring less frequently than more moderate events. Flood forecasting by application of hydrologic techniques is used for warnings. The objective of frequency analysis of hydrological data is to relate the magnitude of extreme events to their frequency of occurrence.

Factors affecting Flood Flow : Floods are primarily due to surface run-off. Therefore, all factors that affect surface run-off also affect flood flow. Two classes of such factors are : (1) those that determine the intensity of the storms that are likely to visit any drainage basin and (2) those physical characteristics of the basin which affect and determine the disposal of that rainfall.

Estimating magnitude and frequency of floods :

(1) Determination of empirical formula : Scores of such formulae have been proposed—their satisfactory use is difficult. (2) Determination by statistical (probability) methods—Prediction from past records. Inherent defect in this method. (3) Determination by the Unit Hydrograph method—the only known dependable method. Continuous precipitation and run-off records are required.

Flood Plains: The flood plain is a strip of relatively smooth land bordering a stream and overflowed at time of high water. A typical flood plain will include the following features : (i) the river channel, (ii) Ox-bow lakes, (iii) Point bars, (iv) Meander scrolls, (v) Dead water or sloughs, (vi) Natural levees, (vii) back swamp deposits and (viii) Sand splays. On large rivers, such as the Mississippi or the Mekong, the majority of these factors are distinctively displayed in what might be called the classic model. The distribution of vegetation on many flood plains reflects the distinctive depositional and erosional environments (Drury, 1956). Available data suggests that the flood plain is overflowed to a depth equal to 8/10 of the mean height of channel banks with a recurrence interval of 50 years. This relation is obviously dependent on the width of the flood plain and, presumably the width of flood plain often bears some relation to the width of channel or size of the river. Two telated processes are responsible for flood plain-formation : (1) Deposition on the inside of river courses and (2) deposition from over-bank flows. As a river moves laterally, sediment is deposited within or below the level of the bankfall stage on the point bar, while at overflow stages the sediment is deposited on both the point bar and over the adjacent flood plain. *Mackin* concludes : "The flood is composed of two parts, distinctly different in origin. The gravel represents the coarsest material moved along the stream channel, and is characteristically unstratified. The overlying silts and clay are deposits from suspension" ! In the absence of aggradation or degradation the flood plain in essence provides storage for sediment in its movement from surface of the drainage basin through valleys to the mouth of the river. Movement of sediment is discontinuous within the channel itself, and temporary storage within the flood-plain lengthens the periods of dormancy. The episoidic character of discharge produces discontinuities in transport. The flood plain is essentially a depositional feature of the river valley, associated with a particular climatic or hydrologic regimen of the drainage basin.

An alternation of the conditions of equilibrium through tectonic changes or by changes in the hydrologic regimen, including changes in sediment and water yield, will result in altering the flood plain and lead to degradation and terrace formation or to aggradation[4].

According to S. P. Chatterjee and K. Bagchi[6], most of the floods in West Bengal are due to the strengthening of the monsoon current over sub-Himalayan Bengal due to westward movement of depressions from the Bay-head and shifting of the axis of the seasonal monsoon trough to the Himalayan foothill. Further, according to Chatterjee and Bagchi, a series of rain storms, originating in the Bay of Bengal travel inward dying out at various distances. They may even enclose the entire catchment areas of one or more rivers. With regard to floods in the Damodar region the following factors, according to Chatterjee and Bagchi, require a scientific enquiry : (1) Friable nature of ground leading to soil erosion and consequent increase in the load of streams ; (2) High levees intensifying depths inside channel, (3) Sagging of a region between West Bengal plateau and Bhagirathi-Hooghly basin and (4) High stage of the Damodar, Bhagirathi-Hooghly and the Rupnarayan.

Again, according to Dr. N. K. Bose, retired Director of the River Research Institute, West Bengal, a number of tributaries join the Bhagirathi on the right bank. All these rain-fed rivulets taking-off from Chotanagpur plateau can become mighty rivers like the Ajay in the monsoon and cause severe floods, with breaches in their embankments.

III. Flood Formulae and Models

The best suited formula is that of Myer. The original formula was : $a = C\sqrt{A}$ (where a is cross sectional area of required waterway in square feet ; A is area of the drainage basin ; C is a co-efficient ranging from 1 to 4 which is indicative of the flood potentialities.

Transforming the area into square miles, M and assuming that the average velocity of flood through the waterway is 10 ft per second, so that $10 \times a$ represents Q, the discharge in cubic ft. per second (c. f. s.), we get

$$Q = 10\,a = 10\,C \times 25.3\sqrt{\frac{A}{640}} = C \times 253\sqrt{M}$$

A simplified version of the Myers formula for an area below 9 squares miles : $Q = C\,i\,A$ (where Q is rate of discharge in cubic ft. per second, C is coefficient representing the percentage of rainfall appearing directly as surface energy. i is average rainfall intensity, in inches per hour, A is drainage area in acres[1].

According to this formula it is coincidental that for a run-off depth of one inch per hour an acre will yeild approximately one cubic feet per second or nearly 2 acre ft. per day.

Based on flood plain analysis, Flood Control Reservoir Designs have been considered in relation to certain models in recent years. The DWOPER Model (Dynamic Wave Operational Model) has been applied to the Mississippi-Ohio-Columbia-Missouri-Arkansas, Tennessee, Ouachita, Yazoo, etc. rivers in the U.S.A. With backwater effects and "mild bottom slopes"—a number of gauging stations were utilised to evaluate the simulation by comparing the calculated and observed water levels and flow rates at those locations. The Dynamic Wave model, as above, can be expanded to consider flow routing through meandering rivers in wide flood plains. Fread (1980) developed a model for meandering rivers, distinguishing the left flood plain, the right flood plain and the channel. Forecasting down-stream flash floods due to dam failure is an application of flood routing. The most widely used dam-breach model used by the National Weather Service of U. S. A. is the DAMBRK model by Fread. This model has 3 functional parts : (1) temporal and geometric description ; (2) computation of the breach outflow hydrograph ; (3) routing of breach outflow downstream. The DAMBRK model can simulate several reservoirs located sequentially along a valley. It was applied to reconstruct the downstream flood wave caused by the failures of Teton Dam in Idaho River (1976). Teton Dam was a 300 ft. high earthen dam with a 3000 foot long crest. By the dam breach, 11 people were killed, 25,000 made homeless and $ 400 million in damage caused downstream. The FLDWAV model is a synthesis of DWOPER and DAMBRK models (Fread 1985).

IV. Measures to Control and Minimise Floods

Relief from Flood hazad : Damages can be avoided by (i) Construction of protective works ; (ii) Reduction of the flood stage and (iii) Reduction of flood flows by storage and change in land use, or similar methods.

Flood Protection Can be achieved to a considerable extent, by levees and flood walls. These constructions protect property no doubt but also increase the stage of the river upstream.

Stage Reduction : A flood channel can be constructed round the city—such as the By pass canal, directly to the Gulf of Mexico, near New Orleans at the mouth of the Mississippi in the U. S. A.

Reduction of Peak Discharge : By storing some of the surface run-off and through change in land use to increase infiltration capacity.

Flood Routing : Flood routing through Reservoirs and River channels.

It will be interesting to note that the nature of flood control measures differs substantially in the upper course of a river from what is recommended to be done in the lower course. While flood routing and river training works (such as straightening of channels) are more effective in the delta course of the river, changes of land-use pattern, afforestation and terracing are highly beneficial in the upper course or in the catchment area. Such differences in attitude were often reflected in the reports of the Mississippi River Commission, in terms of priority works recommended. Near home in eastern India the Reports of the 21st Engineers' day on Monitoring Natural Disasters[10]. U. R. Sinha and B. K. Prasad while discussing the "Flood Fury in Gangetic Plains" stressed on the need for the proper survey of river catchment, continuous repair and maintenance of earthdams and river training programmes. The Damodar floods were primarily due to the gradual depletion of a forest cover and damaging land-use practices in the catchment areas. Many of the North Indian rivers suffer from the same or similar maladies in their sub-Himalayan Courses. What is needed in this land of rivers is a proper maintenance of Hydrological data, a continuous monitoring of this data store, forecasting along the latest scientific lines and a modern warning system—all this to minimise damage in times of actual flooding but more than that comprehensive studies on river behaviour and a vigorous research programme in river training should be undertaken as a long term policy. Instead of our reliance on a narrow range of options—of relief and emergency actions year after year, permanent safety measures should be aimed at with the help of computer technology, by utilisation of scientific data on river regimes and hydraulics.

V. Perception of the Hazard

No study of a natural hazard is complete today without a consideration of its perception aspect, as made out by Behavioural Scientists. The portion of the "operational" environment of which man is aware is his "perceptual" environment. Persistence of settlements in hazardous areas has been a queer phenomenon in all lands, at all times. The inhabitants' view of the hazard has been sought to answer many of our scientific queries. Their perception of the hazard consists of a high degree of abstraction and generalisation of a complex reality. The major adjustments to hazards usually take place in response to crises. Each crisis tends to produce a flurry of public works programme or studies. Another tendency is to emphasise technological solutions rather than possible social and behavioural adjustment. *Thus, dams and levees built in flood plains tend to lull the flood plain user into an often false sense of security to lure him toward even more hazardous zones.*

Julian Wolpert[6] has studied in great depth the behavioural aspects of the Decision to Migrate—from a hazard prone area to safety (1985). "Variations in perception among hazard zone occupants have been explained in terms of three main factors : (i) the relationship of the hazard to the dominant resource use, (ii) the frequency of occurrence of the hazard, and (iii) variations in the degree of personal experience".

Thomas F. Saarinen[7], the noted hazard perception analyst has tabulated the 'Common Responses to the Uncertainty of Natural Hazards' in the following manner.

Eliminate the Hazard	Eliminate the Uncertainty	Transfer uncertainty to a higher power
Deny or denigrate its existence "We have no floods here only high water" "It can't happen here"	*Making it determinate and knowable* "Seven years of great plenty... after them seven years of famine".	"It's in the hands of God"., "The Govt. is taking care of it".
Deny or denigrate its recurrence "Lightning never strikes twice in the same place" It's a freak of nature	"Floods come every five years".	

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PROBLEMS OF DROUGHT : INDIAN PERSPECTIVE

BIRESWAR BANERJEE*

Introduction

Drought is of frequent occurrence in India since time immemorial. It is a common phenomenon of the arid and semi arid lands. Major part of India is located within the tropical and sub-tropical climate. Moreover the climate of this sub-continent is largely determined by the monsoon, which is noted for its erratic and uneven character. As such, the incidence of drought is common in India. It has been estimated that about one-fifth of the total population of this country suffers from acute drought conditions. About 15 p.c. of her population live in this drought-prone area.

Quite often this natural hazard causes immense suffering to the people, due to acute scarcity of water, fall in crop production, shortage of fodders, drying up of river beds, fall in ground water table, wilting of natural vegetation as well as damaging the Productive quality of soils. In other words, drought causes immense ecological and social imbalances. Recently environmental scientists are particularly concerned of this natural hazard, because of its more frequent occurrence and its gradual expansion from the arid and semi-arid parts over to the sub-humid climatic regimes of India. The problem attracts attention in view of the urgent need for augmenting food production of this country from its existing level of 160-170 million tonnes to 220-230 million tonnes to meet the needs of her people by the end of this century. This has to be achieved from the existing or even from much restricted farm lands than present. Moreover the agricultural sector is faced with the task of meeting the fodder needs of her livestocks, and raw materials of agro-based industries. The drought naturally acts as a hindrance to agricultural productivity due to deterioration of the quality of land. Its negative impact prevails for even longer period after its actual occurrence.

Definition

The definition of drought is complex and varies from one region to another. This is because of the differential moisture requirements of plants—in types as well as in space. As such an universally accepted definition of drought has yet to be evolved. Though it is a meteorological phenomenon, its immediate impact on crop production is significant. It, however, signifies prolonged periods of moisture deficiency and increased evapo-transpiration. It is also a period of sufficiently prolonged dry weather, causing serious hydrological imbalance to disturb the natural ecosystem. The period of moisture deficiency is usually extensive, both in space and time.

Classification

This natural hazard has been broadly classified into three categories, namely (i) meteorological drought, (ii) agricultural drought and (iii) hydrological drought.

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(i) *Meteorological Drought* : To a meteorologist, a drought occurs when there is a decrease of average annual rainfall over an area by about 25 p.c. or more from the normal. When the deficiency is between 25-50 p.c. it is of moderate category and when it is over 50 p c. it is of severe type. This feature is usually common in the arid and semi-arid parts of the country, where the average annual rainfall is 750 mm or less.

(ii) *Agricultural Drought* : Agricultural drought signifies prolonged periods of rainfall deficiency from the normal. It takes into account soil moisture along with rainfall. So agricultural drought takes place when the rainfall and soil moisture are not able to meet the minimum requirements of plant growth. It may occur at any period during the life cycle of a plant, thereby affecting its growth and may even result in wilting. Unlike meteorological drought, this type of hazard may arise from irregular and variable rainfall. This type has considerable impact on the crop production of any region.

(iii) *Hydrological Drought* : This is also caused by a long period of dry spell, as a result of which tanks, lakes, streams and even rivers are dried up. There is also a significant fall in ground-water table. The surface run-off may be less than 75 p. c. of the normal.

All these categories, however, indicate prolonged period of rainfall deficiency. But drought should not be considered only on the basis of shortage of rainfall. It should also take into account the availability of moisture in the soil on which the life-cycle of the plant depends.

The various criteria adopted above indicate that this natural hazard is related to a period of dryness caused by poor rainfall or desiccation of soil moisture preventing the growth of plants. The criteria of classification, therefore, varies from place to place even in this country. The National Commission of Agriculture (1976) has defined agricultural drought when the weekly rainfall of a region is 50 p.c. or less from the normal for a period of 4 consecutive weeks during mid-May to mid-October. This period coincides with the monsoon which is the most important cropping season over major part of this country During other periods, 6 such consecutive weeks of dry spell are termed as drought. Though the average annual rainfall of Tamilnadu is more than 1,000 mm, the region also suffers from period droughts. In this State where and when the average annual rainfall is 900 mm or less and where less than 35 p c. of the cultivated area enjoys irrigation facilities are considered drought-prone areas. In Karnataka, the areas where the rainfall is less than 400 mm during kharif and 150 mm in rabi season, are considered to be suffering from drought. In the Eastern States where the rainfall variability is more than 30 p.c. during karif season and 20 p.c. during the crucial stages of plant growth, drought conditions prevail. In most of these cases, more emphasis is given on the scarcity of rainfall than on the availability of soil moisture in determining drought conditions.

Identification of Drought : Some Parameters

There are several parameters for the identification of drought in India. It has been apparent from above that till now the scientists prefer to give emphasis on rainfall as the main parameter for the identification of drought. Some of the common parameters for the identification of this natural hazard are :

(i) *Deficiency of rainfall* : Where the average annual rainfall is less than 750 mm, the region is more susceptible to drought.

(ii) *Rainfall variability :* If the annual and seasonal variation of rainfall are

30 p. c. or more, the area is said to be drought affected.

(iii) *Deficiency of surface run-off*: If the surface run-off of a region is less than 75 p.c. of the normal for a number of years, the area is said to be suffering from drought.

(iv) *Soil moisture deficiency* : The Central Arid Zone Research Institute (CAZRI) has given more emphasis on the availability of soil moisture during the growing season as a major parameter in drought identification. It is determined on the relationship of actual evapo-transpiration with potential evapo-transpiration. It may be mentioned in this connection that climatic factors like temperature, evapo-transpiration, loss of soil moisture and assessing the moisture requirement of individual crop also form important parameters in drought identification. So drought can be evaluated in a more meaningful manner by careful computations of water surplus/deficit in the soil on daily/weekly basis. In other words, water budget/balance method formulated by Thornthwaite and Mathur may be considered as the most important scientific parameter in determining agricultural drought of a country like India with diverse ecological niches. (C. W. Thornthwaite and J. R. Mathur, (1955): The Water Balance. Pub. in Climatology, Vol. 1, No. 1, U. S. A.).

It has thus become quite apparant that agricultural drought in this country is caused by an imbalance between soil moisture and crop requirements. As such the identification criteria should be based on the amount, periodicity and distribution of rainfall on the one hand, and availability of moisture in the soil and its evapo-transpiration losses at the other.

Genesis of Droughts

It is evident from the above discussion that the genesis of this natural hazard lies on shortage of rainfall, annual or seasonal. In India, this is particularly true because of the erratic behaviour of the monsoon wind. The monsoon season is not a period of continuous rainfall but it comes in rhythmes. It has got pulsating character.

The mechanism of the Indian monsoon is rather complex. The causes of its erratic character has not yet been deciphered. Rainfall during this period is associated with the lifting up of moist air mass bordering the peninsular coasts, its inter-action with the cyclonic depressions of marine origin and association with the jet stream higher up. The movement of the monsoon wind is partly associated with the relative location of low pressure and high pressure troughs of this sub-continent, as well as with the alignments of the uplands and plains. This explains the variable nature of the monsoon rainfall over this country, both in time and space.

On a much wider spectrum, scientists have noticed a gradual warming up of the earth's atmosphere. The CO_2 content of the atmosphere has recorded an increase by about 10 p.c. since the beginning of this century. Combustion of fossil fuels on a large scale may be a contributory factor for such an increase. Gradual depletion of forests to provide space for new settlements and industries have disturbed the absorption capacity of the CO_2 by our natural vegetation. In other words, the surface temperature of the earth is gradually increasing due to higher proportion of CO_2 in the air. But the temperature aloft is not raised compared to the surface. So a marked thermal gradient is developed between the surface and upper air. This phenomenon may disturb the seasonal rainfall pattern specially in the tropical and sub-tropical lands. The *Greenhouse Effect* noticed in some parts of the world may be a factor for frequent recurrence of droughts than before.

Besides scarcity of rainfall, shortage of water during drought may be associated with a change in the prevalent pattern of land use. Soil moisture decreases in case of an increase in human and livestock population. Introduction of intensive farming without a change in cropping technique may also result in drought. In many regions, recent change in the prevalent land use pattern has augmented the evapo-transpiration rate thereby creating agricultural drought. It seems likely that the drought has its genesis on a combination of both natural and human agencies.

Farming in Drought Affected Areas

The areas which suffer from periodic or frequent droughts are termed as drought-prone areas. The major occupation of the inhabitants of these areas are farming and livestock raising. The crop-productivity of these areas is low and yield unstable. Inadequate marketing, credit and other infrastructural facilities are the reasons of their backwardness. These areas usually grow coarse grains viz., millets, oilseeds and pulses.

In India, 128 out of about 445 districts record less than 1000 mm of rainfall having limited irrigation facilities. Within these districts, about half of the net sown area of the country is located. These districts are mostly located in the central Indian highlands, Peninsular plateau and in the semi-arid and arid deserts of the west. Though these areas suffer from ecological and social disadvantages, it has recently been realised that they possess enough potentiality for the future, provided suitable measures of water conservation and water budgeting are adopted for the scientific use of available land resources. Recent experiments have shown that the productivity of these drought-prone areas can be augmented by 30-70 p.c. with the help of appropriate soil and moisture conservation techniques. During the critical periods of drought, the standing crops can be protected through water harvesting. In this technique, whatever surplus surface water is available during the short spell of rain is diverted and stored in tanks located at lower levels for use by the wilting plants. Similarly evapo-transpiration of the soil moisture can be minimised by covering the soil with some covers from the scorching heat of the sun. Dissemination of modern innovations in dry farming at the grass-root level still remains at a rudimentary stage. Attention should be focussed to this end.

Conservation of soil and water resources should, therefore, be given top priority in the future growth of drought affected areas. Side by side, the distressing socio-economic conditions of the poor and landless farmers and agricultural labourers clinging to their extremely fragmented and tiny holdings of the dry lands should be taken care of. The various measures so far adopted to improve the economy of the masses living in this fragile environment, should ensure equitable distribution of developmental benefits to all sections of the society.

Outlook

In view of the fact that about two-thirds of the total area of this country occassionally suffer from seasonal or periodic drought and semi-drought conditions, it has now become imperative to adopt suitable measures of dryland management by adopting more efficient dryland farming and meaningful use of other resources of the region.

Drought should neither be considered as a natural hazard *per se*, nor an isolated phenomenon. It is linked with our approach to the management of the country's land and water resources. Hence drought is a component of a much wider spectrum of an interacting ecosystem. Recurrence of drought is very difficult to check. But its negative influence on our society can be mitigated, if you know the art and scientific technique to live with it. ☐

OCCUPATIONAL HAZARDS OF IONISING RADIATION AND THEIR MANAGEMENT

G. MUTHUKRISHNAN*

Introduction

The operation of the atomic pile in Chicago in 1942, by Fermi has demonstrated the application of nuclear energy for peaceful purposes viz production of electricity from the heat produced and for military purposes through the production of plutonium to make atom bombs. In addition, nuclear techniques are being applied in other fields such as cancer therapy, medical diagnosis, x-ray imaging, food irradiation, tracer techniques, industrial radiography, sterilisation etc. Benefits derived from any technology are known to carry some risks along with them. The nuclear industry recognised the deleterious effects of radiation on man as early as 1928 and the International Commission on Radiological Protection, popularly known as ICRP was formed to formulate guide lines on the widespread uses of ionising radiation.

Effects of Radiation

The deleterious effects produced by irradiation of the human body can be classified into acute effects, which manifest themselves immediately or within days following the irradiation and long term effects which have a well-marked latency period between exposure and manifestation of the effects, usually between 5-25 years. Long term effects include[1] induction of malignancies, abnormal developments following irradiation of foetus, inherited abnormalities in descendents of exposed persons.

The effects can also be classified as :

Stochastic effects—in which the probability of the occurrence of a health effect following irradiation increases with the dose and for which no threshold exists.

Non-stochastic effects—in which the severity of the health effect increases with the dose and which has a definite threshold.

Carcionogenesis, leukemia and hereditary effects are stochastic effects whereas cataract formation, infertility and life-shortening are non-stochastic effects.

Principles of radiation protection

The aims of radiation protection are to prevent completely the detrimental non-stochastic effects and to reduce the incidence of stochastic effects to a value acceptable to the society[2]. Let us elaborate on the point "Value acceptable to the society." It is quite evident that it is impossible to eliminate completely the stochastic effects, unless the society is willing to spend an exorbitant amount not commensurate with the benefits. Consequently, one has to arrive at a value which is considered to be safe. One has to perform the cost-benefit analysis to arrive at the quantum of radiation which is acceptable to the society[3]. The detrimental effect is called the risk, which means the chances of death or harm.

Society is not prepared to accept a risk of the order of 10^{-3} in any industry. Society will spend money to reduce the risk in any

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industry of the order of 10^{-4} or less without consideration of cost Society will be prepared to spend money to reduce the risk of 10^{-5} or below, provided that the reduction in risk commensurates with the benefit. It is highly uneconomical to aim at a risk of the order of 10^{-6} or less. Thus optimisation aims at reducing the order of the risk to a value which is acceptable to the society. This also should not impose an unduely high economic penalty. Further, the cost involved should be commensurate with the benefit that may accrue.

The recommendations of the ICRP form the basis of radiation protection For this purpose people are divided into two categories :

(i) Radiation workers who by nature of their occupation, receive radiation dose either at high dose-rates for shorter periods of times or at lower rates over extended periods of time and whose radiation exposures are individually monitored at their place of work and who undergo periodical medical examination.

(ii) Members of the public who live in the neighbourhood of a nuclear installation and who receive radiation exposure due to radioactive discharges from nuclear installations.

The dose limit to the members of the public is 1/10th the dose limit to a radiation worker for the following reasons :

(i) Occupational exposure is voluntary i.e. the hazard can be overseen whereas for the public the exposure is imposed.

(ii) The public living in the neighbourhood may not be benefited directly from the installation.

(iii) There is constant evaluation and control within the plant thus enabling remedial measures to be taken promptly.

(iv) Occupational workers are screened and selected. Periodical medical examinations are held for them during their occupation.

(v) General population contains peoples of all age groups including children and embryos which are more radiation sensitive and older citizens who may feel the impact of exposures more than the others.

(vi) The number of years of occupational exposure is less than the number of years of environmental exposure.

(vii) It is not advisable for each industry to impose its full measure of the occupational hazards on the environment.

In the views of the ICRP, no practice involving radiation exposure should be permitted unless it produces a net positive benefit. All exposures should be kept As Low As Reasonably Achievable (ALARA) taking into account the economic and social factors. However this radiation exposure to the individual shall not exceed the annual dose equivalent limits recommended by the ICRP.

These principles form the basis for radiation prevention and protection of environment. The ICRP maintains constant interaction with successive Radiological Congresses and reviews its recommendations from time to time, based on the additional information available on the biological effects of radiation. Thus the dose equivalent limits in use now were actually evolved based on data developed over a period of 50 years. The risk coefficients developed by the ICRP is given in Table 1[1].

The annual dose equivalent limit (DEL) to the radiation worker is 5 Rem/year whereas for the general public it is 0.5 Rem/year.

TABLE 1 : **Risk Coefficients recommended by ICRP**

Organ	Risk per rem of exposure	Nature of health effect
Gonads	1×10^{-4}	Serious hereditary ill health within first two generations
Red bone marrow	2×10^{-5}	Leukaemia induction
Breast	2.5×10^{-5}	Breast cancer
Lung	2×10^{-6}	Lung cancer
Bone	5×10^{-6}	Bone cancer
Thyroid	5×10^{-6}	Mortality from thyroid cancer
Other organs	5×10^{-5}	Induction of malignancy
Total Stochastic Risk	1.4×10^{-4}	

Since the aim of radiation protection is to limit the stochastic effects which are probabilistic in nature, to a small value, it is not only necessary to estimate the dose to the individual but also it is essential to know the total number of persons in that dose range. Thus the average dose and the risk involved to the community in that vicinity can be estimated.

In order to ensure that the exposure to the public does not exceed the DEL, the exposure at the boundary of the installation is kept below this limit which is achieved by providing an exclusion zone around each installation In order to limit the radioactive discharge Derived Working Limits (DEL) are calculated from the DEL's. For this purpose the DEL's are apportioned to the water, air and land routes. If there are more than one installation in a particular locality, further apportionment is made so that the total dose does not exceed the DEL. A reserve on the dose limit is also made for future expansion and for new installation.

Environmental assessment

In order to assess the impact of any installation on the environment, environmental studies are carriedout in the pre-operational and the operational phase. In the pre-operational phase, critical pollutants, critical group of population, critical pathways leading to the exposures of the members of the public are identified. From these studies one can get information on the background radioactive level in the vicinity and distribution of radioactive material in various matrices of the environment and estimation of the recipient capacity. Thus one can find out the critical pathways of exposure and the dilution capacity of the environment. Through study of stable element distribution, one can collect data on bioaccumulation factors for potentially hazardous radio nuclides. These studies help us to derive the rate of uptake of trace elements and possible isotopic distribution effects. Micrometeorological characteristics are also studied for the evaluation of the atmospheric dispersion of radio nuclides.

The pre-operational data serves as the baseline data upon which any impact on the environment noticeable can be attributed to the installation and its operation. Routine surveillances are carried out which help in detecting any effect on the environment not foreseen till then and also to check on the adequacy of the effluent treatment capacity. These data are useful estimating the quantum of radioactivity that can be released to the environment without unduly endangering it.

Radioactivity releases to the environment can result in exposure to persons in many ways such as from sources external to the body and through intake of material through food, water and air. Figure 1 shows the exposure pathways for atmospheric releases and Figure 2 gives the exposure pathways through the aquatic environment.

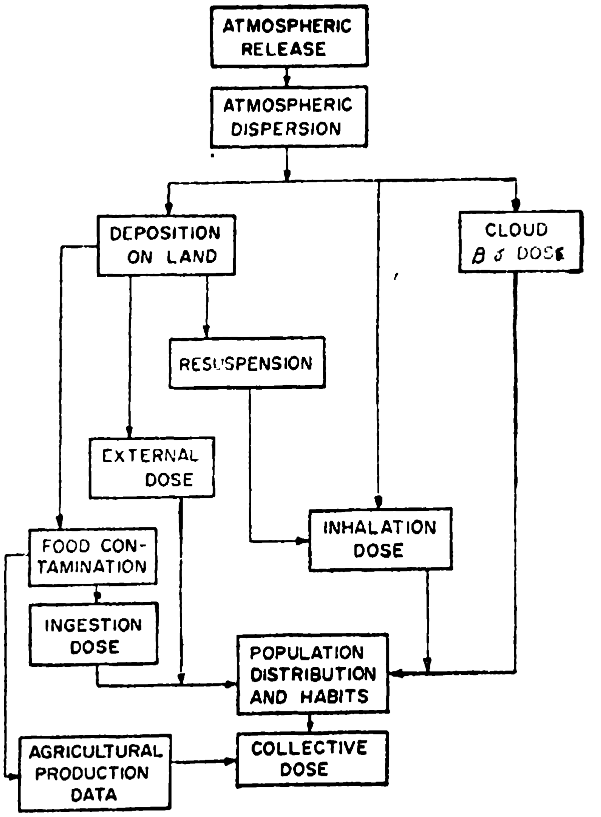

Fig. 1. Exposure pathways for atmospheric releases.

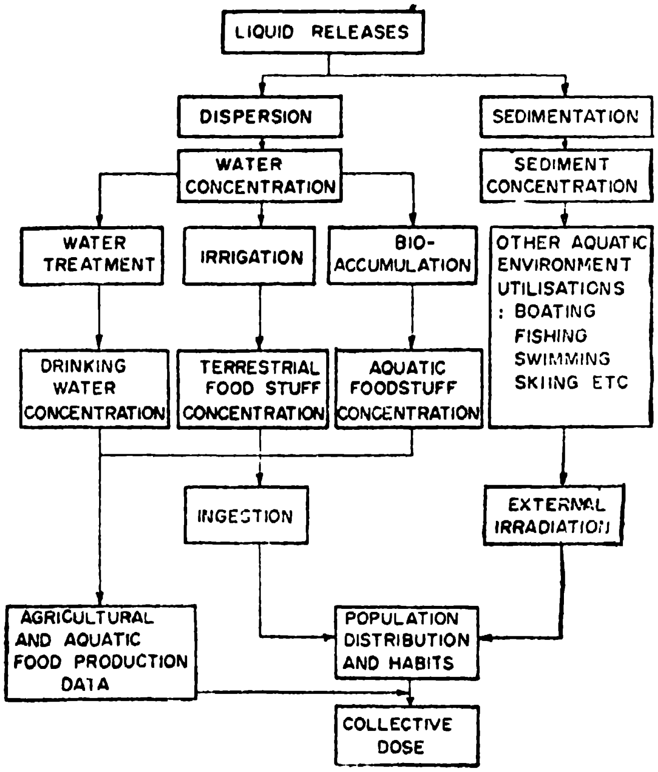
LIQUID RELEASES
DISPERSION
SEDIMENTATION
WATER CONCENTRATION
SEDIMENT CONCENTRATION
WATER TREATMENT
IRRIGATION
BIO-ACCUMULATION
OTHER AQUATIC ENVIRONMENT UTILISATIONS : BOATING FISHING SWIMMING SKIING ETC
DRINKING WATER CONCENTRATION
TERRESTRIAL FOOD STUFF CONCENTRATION
AQUATIC FOODSTUFF CONCENTRATION
INGESTION
EXTERNAL IRRADIATION
AGRICULTURAL AND AQUATIC FOOD PRODUCTION DATA
POPULATION DISTRIBUTION AND HABITS
COLLECTIVE DOSE

Fig. 2. Exposure pathways for releases to aquatic environment.

Thus it is clear from the above pathway figures, that the radioactive material, once released to the environment can disperse and spread in many ways. Because of this nature, establishment of a relationship between the amount of radioactive material released to the environment and resulting dose to the man is difficult. However for any given release of radionuclides, it is possible to identify a limited number of exposure pathways, known as critical pathways and the nuclides known as critical nuclides. It is also possible to identify one or two critical groups within the population which is potentially exposed to the radiation The critical groups by virtue of their special characteristics, such as age, food-habit, occupation etc. will receive radiation more than others. Hence adequate protection to this group ensures protection of the population as a whole. The factors that need to be considered in the identification of critical groups include :

(i) Location and age distribution of potentially exposed population.

(ii) Dietary habits such as special food-stuff and quantities consumed.

(iii) Special occupational habits such as handling of fishing gear etc.

(iv) Type of dwelling, shielding characteristics etc.

(v) Domestic habits such as amount of time spent indoors etc.

(vi) Hobbies such as sports, swimming, fishing etc.

The critical group should be as homogeneous as possible with respect to the above-mentioned factors. A representative of the critical group itself should then be studied in more detail to assess the radiation exposure.

The average exposure should then be regarded as typical of that of the most highly exposed individuals.

In the case of atmospheric releases, the usual reconcentration process to be considered, is the deposition of radioactivity on herbage consumed by grazing animals. Since some animals like cows, sheep etc. graze over a larger area, they act as collectors of radioactivity. The produce of such animals, particularly milk will be a critical food material. Various meteorological factors to be considered can be classified into influencing factors, exposure pathways and monitoring. Influencing factors themselves can be classified into process factors, source factors and meteorological factors. Process factors include emission rate, temperature, form, cocentration, particle size and chemical interactions of the emission products. Stack height, diameter, stack velocity etc. determine the source factors. Meteorological factors to be considered are wind speed, direction and frequency, temperature and humidity and atmospheric stability and lapse rate[5]. With suitable model for exposure pathways, one can calculate the external dose to the wholebody, internal dose due to inhalation, ground deposition and internal deposition through ingestion of vegetables, water, milk, meat and other food products. Regular monitoring of atmospheric and radiological parameters ensure the invariance of the ambient radiation level.

In order to ensure that the dose received by the people does not exceed the DEL, one has to measure the dose received by individual and take necessary measures. Since in practice it is very difficult certain environmental radiation levels such as radioactivity in water, air or radiation level in some fixed places can be measured and a limit can be fixed on them. These limits are worked out, taking into account the amount of water and food consumed in a day average daily breathing rate and amount of time spent in a particular area etc. These measurements can then be related to the discharge rate from the plants and hence discharge from the plant can be controlled. These levels are known as derived working limits (DWL).

Conclusion

It can be said in conclusion that the nuclear industry is the only industry which has taken cognisance of the deleterious effects of its effluents and ever strives to reduce the deleterious effects to a value as low as reasonably achievable, taking into account various economic and social factors. ☐

References

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[2]M. R. Srinivasan and T. Subbaratnam, "Environmental Impact of the Nuclear Power Industry—Kalpakkam Project," Paper Presented at the Seminar on "Environmental Pollution in the Madras Metropolitan Area"—November 24-25, 1980.

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CHEMICAL LABORATORIES AND INDUSTRIES : ACCIDENTAL ACCIDENTS AND DISASTERS

R. N CHAKRAVARTI*

DICTIONARY meaning of 'accident' is mishap resulting from carelessness, unawareness, ignorance or unavoidable causes, whereas 'accidental' means—occurring unexpectedly or by chance. The term 'accidental accidents' thus covers accidents occurring unexpectedly or by chance. If a normally careful worker commits an error one day there may not be an accident, but this should not encourage anyone to become regularly irregular. Smoking near flammable solvents does not always results in fire, but if this becomes the practice, one day there may be a serious fire.

Though accidental accidents do sometimes take place, if a proper study is made it will be found that most accidents are due to carelessness or negligence and not strictly by chance. Even a careless worker tries for an escape route to establish that the accident has taken place purely by chance and not due to his carelessness, and if one tell him—"Why were you smoking near flammable materials ?" —his smart reply might be that he was doing like that all the time, though it is grossly unreasonable. Burning cigarette ends have been the cause of disastrous fire not only in laboratories, industries and godowns but also in office buildings. A burning cigarette end may remain quietly active for a considerable period and may slowly and gradually start a fire inside closed doors when all might have left, though ultimately in official reports such cases might appear as due to electrical short-circuit. While at the Indian Institute of Experimental Medicine, we had a similar night fire, put out by the fire brigade, in a closed laboratory although the electrical lines were all well-maintained under the care of efficient staff.

The following is an extract from the Daily Telegraph, London regarding a fire at the Dyson Perrins Laboratory, Oxford early in July, 1946 :

> "Prompt action by an Indian scientist recently saved the country many thousands of pounds Mr. Morrison, Lord President of the Council, told delegates to the Commonwealth Scientific Official Conference at a dinner at Claridge's Hotel, W., last night. Sir Shanti Swarup Bhatnagar, leader of the Indian scientific delegation was walking along a road in Oxford early this month when he noticed flames coming from the Organic Chemistry Laboratory, where Sir Robert Robinson, President of the Royal Society, works Sir Shanti Swarup tried to enter the laboratory and give an alarm, but the door was locked. So he climbed to a window, forced it open, climbed in and extinguished the fire, saving the building and its valuable contents."

This incident took place on a bright Saturday afternoon during the summer vacation of the Dyson Perrins Laboratory on South Parks Road, Oxford, while there was none in the building. I was there in those days working with Sir Robert and came to know about the incident from Sir Shanti Swarup the next day (Sunday) when I met Prof. J. N. Mukherjee, also a member of the Indian delegation, at the Magdalen College guest house.

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The following is quoted from an obituary on Sir Robert Robinson by me published in the *Science and Culture* (Vol. **42**, 1976, pp. 208-210) regarding another fire at the same laboratory while I was there :

> "It is worth recording an incident that took place during the writer's stay at the D.P. Others with him in different periods might have come across many such memorable incidents. One afternoon in 1946, while the Storekeeper was trying to melt a winchester of solidified tertiary butyl alcohol rather carelessly over a Bunsen flame, there was a fire. Curling black smoke started coming out from the room and the furniture also caught fire. The position became threatening. Sir Robert did not allow any of the workers to do anything except bringing the fire-extinguishers from the different places and giving those to Lady R. (i.e. Lady Gertrude Maud Robinson). who handed those over, one by one, to him as the previous one got exhausted. She was saying repeatedly, "Oh Robbie, do be careful", while he was steadily carrying out the job like a master, an expert in the art. The fire brigade came after the fire was put out.

In a laboratory in a western country, the doors and windows are usually kept closed and while working with flammable solvents, in spite of the exhaust system, the space sometimes becomes filled up with the vapour. While I was working at the Converse Memorial Laboratory, Harvard University, in 1947-48 there was a minor explosion like a flash when Prof. R. B. Woodward entered such a small laboratory room with his usual burning cigarette.

From a report of *Oxford Mail* of 19 April 1980, it is observed that on the previous day at the Dyson Perrins Laboratory, Oxford University, a student, Robert Elliot, lost his fingers and was badly burnt when tropylium perchlorate, which he was powdering in a mortar with pestle, exploded. He was wearing safety glasses and thus his eyes were unaffected. He had to undergo plastic surgery. This is a localised accident though of a serious type, and others in the room had nervous upset only. Immediate steps were taken by Prof. Jack E. Baldwin. It appears that the direction Elliot was following was defective, as it is not desirable to grind perchlorates like that in the dry condition. Had it been part of an industrial process one might guess the intensity and extensive nature of the disaster that might have followed as the quantity involved would have been very large and the number of persons also large while experienced persons like Prof. Baldwin might not be there.

A large number of accidents take place in the laboratories due to the habit of some for drinking water, without proper labelling, cooled in a refrigerator, which is normally being used for laboratory work. There are similar other cases where an individual is mostly affected. Such cases normally do not take place in the industries. Long time ago, Prof. M. Q. Khuda of Presidency College, Calcutta just saved himself, but for the agonies for sometime, after drinking only a little of an alkali solution from the refrigerator thinking it to be drinking water. A more or less similar case took place around 1957 when Prof. T. R. Seshadri, at the Chemistry Department of Delhi University drank a little of water containing hydrocyanic acid from the refrigerator taking it to be drinking water. But a worker at the Bose Institute, Calcutta died after taking ice-cold ammonia solution from the refrigerator also taking it to be drinking water. A worker died of nux vomica poisoning resulting from sucking in strychnine solution through a pipette in the Applied Chemistry Department, Calcutta University. The jet end of a pipette must definitely be inside the liquid all the time the liquid is sucked up. Now a days, auto-devices are available for use without sucking by mouth for such purpose. Some years back, 4 workers of Geological Survey of India, Calcutta died after taking by mistake thallous sulphate (rat poison and ant bait) as sugar in tea.

While I was working at Oxford with Sir Robert Robinson during 1945-47, resulting in finalisation of the structure of strychnine, I had to work with very large quantities of strychnine, and at tea time I used to take tea, with great caution, in a beaker—with the poisonous products all around the table. In fact in those days I often used to get a bitter taste in my mouth due to strychnine dust around me and this perhaps stimulated me to work with great vigour and to push my research to a very dramatic and successful end. Robinson got the Nobel Prize for 1947 only a few months after that, while I was working at Converse Memorial Laboratory of Harvard University with Prof. Louis F. Fieser on natural steroids.

I had my serious initial hurdles at Oxford as others of the laboratory failed to prepare neostrychnine from strychnine (also neobrucine and neostrychnidine) by my method by refluxing strychnine with Raney nickel catalyst in xylene. The Australian chemist, Dr. K. H. Pausacker had a serious fire and two others also failed to get neostrychnine by the method. So I had to train up an English chemist, Dr. A. S. Bailey from the very beginning of the preparation of the catalyst up to the end of preparation of neobrucine from brucine and thus Robinson became convinced about my method. Nevertheless, in a humourous mood he told me that some were saying—"Only Chakravarti can make it." It is a heterogeneous catalytic reaction. After numerous trials, heating on sand-bath for long hours was found necessary. The catalyst is heavy and readily settles down but due to heating on the sand-bath there is intermittent bumping and thus it becomes a well-dispersed suspension again. To prevent accident during the bumping over long hours of heating it is necessary to fix the sand-bath tight with the tripod stand and to clamp the flask and the upright condenser tight using a heavy stand. Robinson's dilemma, when I came to know about it, could be smoothly cleared when he understood that Prof. D. S. Tarbell of U.S.A. failed as he used a modern gadget, an electrically heated oil-bath in place of the back-dated sand-bath, and had smooth boiling and no bumping with the catalyst remaining inactive as sediment at the bottom of the flask and naturally no conversion of strychnine to neostrychnine took place. The South African chemist, Dr. A. M. Stephen, following a misconceived procedure for preparation of the catalyst, had a coat of aluminium hydroxide on his catalyst and thus the inactive catalyst failed to carry out the conversion. And Pausacker's fire was due to failing to tighten the sand-bath with the tripod stand and as a result during the heavy bumping the sand-bath (i.e. iron pan with sand on it) gradually slipped out and the fllask came in direct contact of the flame. Where as I worked out the conversion using strychnine, brucine and strychnidine so many times during the two years there with very large quantities of xylene boiling overnight without any accident, he had the fire in early evening using only a small quantity of xylene because of not taking proper precaution according to my direction. It may be noted that stirrers using lubricating grease as also mercury-sealed stirrer were found to poison the catalyst and in those days magnetic stirrers with electric heating arrangements were not available although these could have solved our difficulties.

During the second Great War in Prof. J. C. Bardhan's Laboratory, Chemistry Department, Calcutta University, we were accustomed to preparation of highly poisonous and dangerous chemicals and accidents were not infrequent.

As a result we acquired considerable experience in dealing with each such case appropriately, but sometimes difficulties arose when elderly people without having regular practice of working with flammable and dangerous chemicals worked in the laboratory. One such case was of Shri Rashbehary Chatterjee, an old bachelor, who earlier worked, as he said, under Sir P. C. Ray. One day while Prof Bardhan was helping him, the reaction mixture caught fire. As Prof. Bardhan was holding the flask with fire at its mouth, I had to run and stop the fire smoothly with an asbestos board while Chatterjee moved backwards fast upto the door and frantically tore-off his fashionable saffron coloured *Khadi* apron with binders at back. I was happy that he ran away instead of taking some awkward step in a frenzy and aggravate the situation. There was a similar case earlier, when getting nothing close to me I took the flask from Prof. Bardhan and stopped the fire by closing the mouth of the flask with the palm of my other hand. The burns I had, not from the fire but from the hot rim of the fllask, were duly cured.

An assistant of Prof. Bardhan had severe burns during an esterification in a current of alcohol vapour. He was not properly trained and could not understand that the inlet tube for alcohol vapour got choked. There was also no safety device to indicate such choking. As a result the boiling alcohol in the flask burst out and the fellow had severe burns and had to be hospitalised for a long period About that time I just started work as an M.Sc research student. A girl candidate while carrying out Victor Meyer's method of vapour density determination in her Pass B.Sc. Physics practical examination at the Scottish Church College, Calcutta died of her burns as her *sari* caught fire from the Bunsen flame at the floor level. Even while carrying out the ethyl borate test for borate, a student died of burns at the Narasinha Dutt College, Howrah possibly resulting from nervous upset and awkward steps Long time ago, an assistant working in the laboratory of Sir John Simonsen at the Indian Institute of Science, Bangalore died from accidental burning of alcohol. A research worker under Prof. Dukhaharan Chakravarti, while alone in the first floor laboratory of Chemistry Department, Calcutta University, faced a serious fire. While the laboratory furniture were getting burnt to cinders, he jumped out of the window and suffered from fracture.

Prof. Bardhan had excellent arrangement for the tables for heating work. Those were covered with leadsheet with raised rims all around with a draining arrangement During any heating work some water was kept flowing along the table and in case of fire these could be profusely flooded with water. After he retired, this laboratory came under Prof. (Mrs.) Asima Chatterjee and a girl student, due to catching fire of solvent spilt* over an electric hotplate, died of severe burns. One should know that the hotplate has redhot element inside it and solvent spilt over the hotplate may readily catch fire. There is immense nervous upset if in such a fire there is dense sooty smoke as in the case of burning of chemicals and solvents with a very high percentage of carbon, e.g. petroleum fractions, benzene, etc. In one such fire in my laboratory at the Calcutta School of Tropical Medicine, during a failure of water supply, an elderly chemist got excited to cool down the flask with a big slab of ice, while another wanted to put a large porcelain basin at the top of the reflux condenser but such steps might have proved dangerous due to possible breakage and spreading of the fire. One came with a carbon tetrachloride (CTC) fire-extinguisher, but I did not like that even as the fire was up to that time well under control in spite of the heavy black nerveupsetting smoke. One should remember that during use of CTC for the purpose copious poisonous phosgene, $COCl_2$, gas is produced. The fire was stopped smoothly with the help of a veteran, illiterate assistant using a soft asbestos board from some distance according to my direction.

While in Prof. Bardhan's laboratory, a lady research worker, senior to me, working in another laboratory of the Department asked me about procedure for carrying out sodium and moist ether reduction. I told her to take the material dissolved in ether floating on some water in a flask with an upright condenser and from time to time insert small pieces of sodium by momentarily removing the condenser. She was very much afraid that sodium in contact with water would catch fire and burning ether would result in a serious accident. But the truth is that sodium has specific gravity intermediate between those of water and ether and hence it remains at the junction of water at bottom and ether above it and thus remains out of contact with air with no chance for fire or explosion. However, the sides of the flask should not have drops of water sticking as these may cause serious problem while dropping sodium into the flask.

During the second Great War, in Prof. Bardhan's laboratory, one morning while I was helping, with none else there, Shri R. Swaminathan, a brilliant scholar with First Class First in B.Sc. (Hons. Chem) (later also First Class First in M.Sc.), with his characteristic enthusiasm and speed he smashed a Winchester full of Conc. sulphuric acid against the corner of the table splashing a good part of it on to me. Lower portion of my *dhoti* and apron just disappeared. After immediate flushing with copious water and then dilute ammonia I had to return home with a borrowed *dhoti* from a neighbouring house. It took considerable time in healing up though I could start working in a week. Later during the War we had to work at night under 'black out' conditions in the light of luminous Bunsen flame. Without checking properly in the very weak light, once I used a bored cork instead of a good cork and poured liquid bromine on my hand. As soon as I felt heavy bromine on the palm of my hand I washed with copious water and then with dilute ammonia. Although I started working in a few days, it took considerable time in healing up.

Once during a clean up and washing out of old bottles, a bottle of sodium scrapings smeared with kerosene was being washed at the tap when a big lump of sodium came out It could be detected by me when it fell into the open drain below the sink. Immediate steps were taken by forcing it to the open drain in the open space outside the room by heavy flushing with water. There the lump melted in the heat, caught fire and harmlessly exploded. On one occasion, when the water supply stopped, to continue a refluxing, I sucked cold water into the upright condenser from an ice-bath used earlier. I got the smell of hydrocyanic acid in my mouth and spit out the water as much as possible. As I could not have water to wash my mouth, I just went to the outside open space. At first I felt somewhat dizzy but soon I recovered. On enquiry I found that one had a reaction using potassium cyanide in that ice-bath and due to carelessness dropped some of it in the bath. While working at Oxford in 1945-47, one day I found moist spots all around the balance with smell of hydrocyanic acid. I created a great row there for rough working with potassium cyanide. The particular fellow acknowledged the mistake, as he was afraid I might report to Robinson, and others became cautious. At Harvard, next year, I had to help a student of Prof. R. B. Woodward in preparation of anhydrous liquid hydrocyanic acid. Like some people, he could not get its smell properly and so he had to be made especially cautious about any leakage anywhere in the elaborate set-up of apparatus.

In Prof. Bardhan's laboratory, I had to help one to prepare large quantities of nitrosomethylurethane, a highly toxic and explosive liquid. It is a potent carcinogen. Though for distillation in vacuum we took various precautions, we were not so much careful otherwise due to ignorance and both of us suffered for a considerable period from severe itching, redness of skin, including eyes, and copious minute pimples. Preparation of phosphorous tribromide is quite a tricky job since each one of the ingredients, yellow phosphorus (spontaneously flammable in air), liquid bromine (highly corrosive, even in vapour state) and carbon bisulphide (highly flammable having the lowest flash point amongst common solvents), is dangerous. One has to weigh the phosphorus properly, immediately after taking it out of water in the bottle and wiping out adhering water with filter paper. As there was an accident in its preparation, while I was working at another place, Prof. Bardhan wanted my help. The students wanted to learn the technique also. I told them to watch my work as critically as possible but never try to help or disturb me or ask any question till I finished the work. It went on smoothly and the yield was excellent. Thus the dangerous chemicals, though they are like venomous snakes, if handled properly with all attention like a snake charmer, may smoothly yield the desired product.

Some chemical reactions, particularly the autocatalytic ones, may initially have a time lag but once the autocatalyst is formed the reaction may proceed faster and faster, e.g. halogenation reactions (requiring light energy to get into activated stage), reactions using fine particles of sodium (requiring formation of sodium ethoxide). In such cases it is always desirable to be very careful, by adding only small amount of the reagent and to see the reaction start before adding more and more of the reagent, and in some cases to be ready to cool down the temperature if the reaction suddenly starts very vigorously and in any case one should be personally careful. Dr. A. D. Kemp (South African), while I was with Robinson at Oxford, had a lot of the reaction mixture with finely divided sodium right on his head from the top of the upright condenser and suffered considerably. A similar accident took place with Prof. Amareswar Chatterjee at Jadavpur University. Long time ago, while Dr. D. K. Banerjee was carrying out preparation of methyl iodide, just by the side of Prof. Bardhan's laboratory, with small amount of iodine 'the reaction was not taking place but when the whole amount was added the reaction became suddenly violent and shoot through the top of the upright condenser up to the ceiling. Fortunately no personal injury was there.

There was an explosion in which a new refrigerator was badly damaged possibly due to radio-sodium coming in contact with water under defrosting conditions in the laboratory of Dr. Suprovat Mukherjee in the Applied Chemistry Department, Calcutta University. One should remember that radioactive disintegration is a spontaneous unimolecular reaction, the rate of reaction being independent of extraneous conditions like temperature, pressure, etc. and as such there is no need to keep radio-sodium in a refrigerator.

Vapour of solvents may make local atmosphere highly toxic. While at the Indian Institute of Experimental Medicine (CSIR), Calcutta, once from near the first floor staircase landing I could get smell of chloroform, quite unusual in that area far away from the laboratories. Immediately I searched for the source and found that in a small room filled with lots of things a large carboy full of chloroform was broken and the workers were moving in haphazard manner to deal with that. The situation could soon be brought under control when only one smart fellow was allowed to enter the room, quickly open up the only window and start the exhaust fan of the small fume-chamber, and come out immediately, while an air-circulator was put at the door blowing a strong draft of air from the corridor into the room.

From the above varied types of accidents in the laboratories one may have some idea how chemical industries may get involved in devastating accidents leading to disasters. In fact in view of work with very large quantities of chemicals, poorer standard of knowledge amongst large number of personnel and lower standard of discipline in the industries as compared to the laboratories, even an otherwise minor accident may develop into a very serious accident in the industries. And in the case of an industry dealing with really hazardous chemicals, mistakes and wrong steps may result in a serious accident and further mishandling, often prompted by trying to suppress matters/evidences, etc. and/or nervous upset amongst the dealing staff may lead to a Bhopal-like disaster of December 3, 1984 at the carbaryl (Sevin) factory of Union Carbide, Bhopal. *It is, however, grossly imprudent to clamour for stoppage of production of all poisonous and dangerous chemicals, however useful those may be in our daily life and progress of civilisation, since such hindrances will put humanity of the present period back to the prehistoric days of jungle life.* Accidents and disasters will take place in spite of all precautionary measures as our country gets more and more involved in chemical industries. Instead of looking at such accidents from the negative side, there should be thorough investigation after each such accident for taking more appropriate stringent measures for avoiding these in future, facing these as a challenge with a positive outlook. *In fact, if we take proper stock of the position for the period this particular factory was in existence, it may be found that much greater number of people died in all the different parts of the country during the same period by drinking spurious liquor in spite of a host of Food Inspectors, Drug Inspectors, Excise Inspectors and the Police of the country.*

Alfred Bernhard Nobel, of the famous and most coveted Nobel Prizes of the scientists of the world, during his researches on stabilisation of nitroglycerine for production of dynamite, was labelled by the administration as a dangerous person in view of a large number of dangerous explosions he had at the experimental stage, but when he did produce the stabilised dynamite by admixture of nitroglycerine with kieselghur he established himself as a great friend of the newer generations of the human society. The huge income from his explosives industry has become the greatest source of incentive towards development of scientists and literateurs of the topmost grade in the world.

Taking the case of the Bhopal disaster, in spite of my keen interest in it I have failed to come to any definite conclusion about the truthful sequence of events prior to, during and after the incident. Carbaryl or 1-naphthyl-N-methylcarbamate (arylam, carylderm, dicarbam, ravyon, seffein or sevin), used as an effective contact insecticide, may cause vomiting, diarrhoea, bronchoconstriction, blurred vision, excessive salivation, muscle twitching, cyanosis, convulsion, coma, respiratory failure to man. The starting material, methyl isocyanate (CH_3NCO) or MIC, b.p. 40°C, is made from phosgene gas ($COCl_2$), which is made from carbon monoxide and chlorine. *All these are highly toxic to man.* Though carbaryl is a crystalline solid, m.p. 142°C, and has vapour pressure only 4×10^{-5} mm mercury, during its exothermic production from MIC and α-naphthol if the reaction gets out of control MIC may explosively leak into the atmosphere along with considerable amounts of carbaryl in dust form. As MIC used for the production may contain some amounts of its own starting materials, methyl amine and phosgene, these are also likely to be there in the leaked gases. It may be noted that MIC has a strong tendency to self-condense into the six-membered symmetrical heterocyclic trimer, N^1, N^3, N^5-trimethyl cyanurate, m p. 176°C, b.p. 296°C, more stable and less volatile than MIC.

Immediately after the disaster, a great confusion was created through publication of all kinds of opinion of a large number of our so-called experts through the horror-story-hungry newspapers. A report came out in a noted Bengali daily of December 9, 1984 stating that a particular expert scientist was convinced that the Bhopal disaster was due to phosgene and not at all due to MIC as this scientist was working with tons and tons of MIC in the laboratory every now and then. *If this is correct then there should not be any risk in manufacture of carbaryl from imported MIC.* During our synthetic work in Prof. Bardhan's laboratory, we worked with considerable quantities of imported Phosgene (in cylinders). How many in this country used it like that I do not know. We also worked with MIC. Also I worked in and seen many laboratories of the world. Nevertheless, I do not know of any laboratory where a chemist worked with tons and tons of MIC every now and then. The statement was rather irresponsible and was apt to create confusion amongst authoritative nontechnical people on the basis of the status of the particular scientist. Such irresponsible statements make any enquiry in this country very difficult, as *here personality is often more influential than science and truth.* However, three months later in their issue of March 13, 1985, this particular daily considerably rectified the position through an article by Tushar Maity with the title indicating that the Carbide Group did not disclose that MIC was poisonous.

Sulphur trioxide and chlorine gas leaking into the atmosphere in bulk quantities have created very serious problems in view of their highly corrosive nature. Sulphur trioxide is usually stored and transported as a strong solution in concentrated sulphuric acid as 'oleum'. Such containers and pipelines often burst creating the problems. In early January, 1985, possibly due to bursting of a pipeline at sub-zero temperature at the Nobel Kemi plant at Karlskoga in Sweden, an explosives plant, a subsidiary of Bofors, leaking sulphur trioxide created serious problems. Similar leakage of sulphur trioxide took place, amongst other places, at Baroda and at Delhi in this country in recent years. On 1st January, 1977 at night a deadly cloud of chlorine gas leaked from a water treatment plant in the East Falls district of Philadelphia in U.S.A. Police and firemen used megaphones and sirens to wake up the residents in the area with orders for immediate evacuation. Over a thousand people were forced to leave the area and more than 200 underwent treatment. A number of leakages of chlorine gas at water treatment plants took place in different parts in our country including Delhi and Calcutta. There were a number of such leakages at Palta Water Works (Calcutta). In one such case, the leakage was detected at 3 a m. on November 18, 1974 and finally controlled at 11-30 p m., i.e. over 20 hours. Neither the Municipal staff nor the firemen could control it and ultimately the experts of the manufacturing firm came with their special outfit and plugged the leak. Towards the end of the last Great War, while I was working as Chief Chemist of a growing manufacturing firm at Calcutta, we were using quite large quantities of chlorine for our productions. The gas used to come in large iron cylinders. My strict instruction was that in opening the valve the key lever should be gently knocked with hand or cautiously with a wooden piece but never with an iron hammer. Sometimes when the cylinders were kept without use for a considerable period difficulties arose and we had to take help of the related staff of the manufacturer.

In July 1976, dioxin, a poison gas, escaped from a Swiss-owned chemical factory at Seveso near Milan, Italy and created serious problem for a considerable period over a wide area involving a very large number of people. Numerous people had to be detoxicated and the Government had to agree to abortion as the material, tetrachloro dioxin (TCDD) badly affects the foetus and the effects are said to be similar to those of radioactivity. Nine years after this incidence, in Basle, Switzerland the parent firm took 100 hours to burn three tons of chemical wastes containing about 200 g of dioxin equivalent to 2,000 kg of potassium cyanide in killing power.

In the night of Saturday June 3, 1989 in a desolate valley in U.S.S.R. there was a serious disaster when two passing trains were involved in an explosion due to leaking fuel gas pipeline and engulfed those in fire. At least 400 people including children bound for a summer camp died or reported missing. The helpful and frank acknowledgement was that it was due to incompetence, irresponsibility and mismanagement. If proper enquiry is made most of the accidents are like this. As *a purely accidental accident*, I may mention that during Christmas fair at end of December, 1974, at Campina Grande, a small village in the extreme north-east of Brazil, 11 children died and 20 persons injured, several of them critically, when during a *sudden thunderstorm* a hydrogen cylinder, struck by lightening, exploded and all around were badly hit by splinters and the fire. The hydrogen cylinder was being used in filling toy baloons.

There are some disasters in chemical industries which may be termed as silent disasters. Such disasters are usually due to our ignorance. Such a silent disaster could be detected in the dyestuff industry, a few decades ago, based on aromatic amines. In many of such factories it was observed that there was considerable incidence of kidney cancer amongst the workers. As a result, the Carcinogenic Substances Regulations 1967 No. 879 of Britain came into force prohibiting manufacture, presence and use of products like 2-naphthylamine, benzidine, 4-aminobiphenyl, 4-nitrobiphenyl, etc. and controlled production of 1-naphthylamine, o-tolidine, dianisidine, etc.

In Figure 1 is presented proper symbols to be used for different types of chemicals on the basis of the hazards involved. The two symbols for *Irritant* and *Harmful* are later useful additions and the others were designed by experts of International Labour Organisation in 1956. Such self-explanatory symbols may be easily understood for proper handling even by illiterate factory workers. Besides the symbols, for proper labelling of industrial chemicals it is necessary to put down in brief information regarding the four items noted at the centre of Fig. 1. Had Jethalal Soni of Ganesh Chemicals Corporation in his 'concoction' of diethylene glycol and sorbitol with 'a dash of glycerine' labelled by him on the drum as 'GLYCERINE NOT FOR MEDICINAL USE' used the symbol for ***Poison*** with skull and cross-bone on the drum and even dropped the portion 'NOT FOR MEDICINAL USE', I am sure the 14 deaths at the J. J. Hospital, Bombay during January 21 to February 7, 1986 would not have taken place (cf. R. N. Chakravarti, *Science and Culture*, Vol. 54, 1988, pp. 259-261). ☐

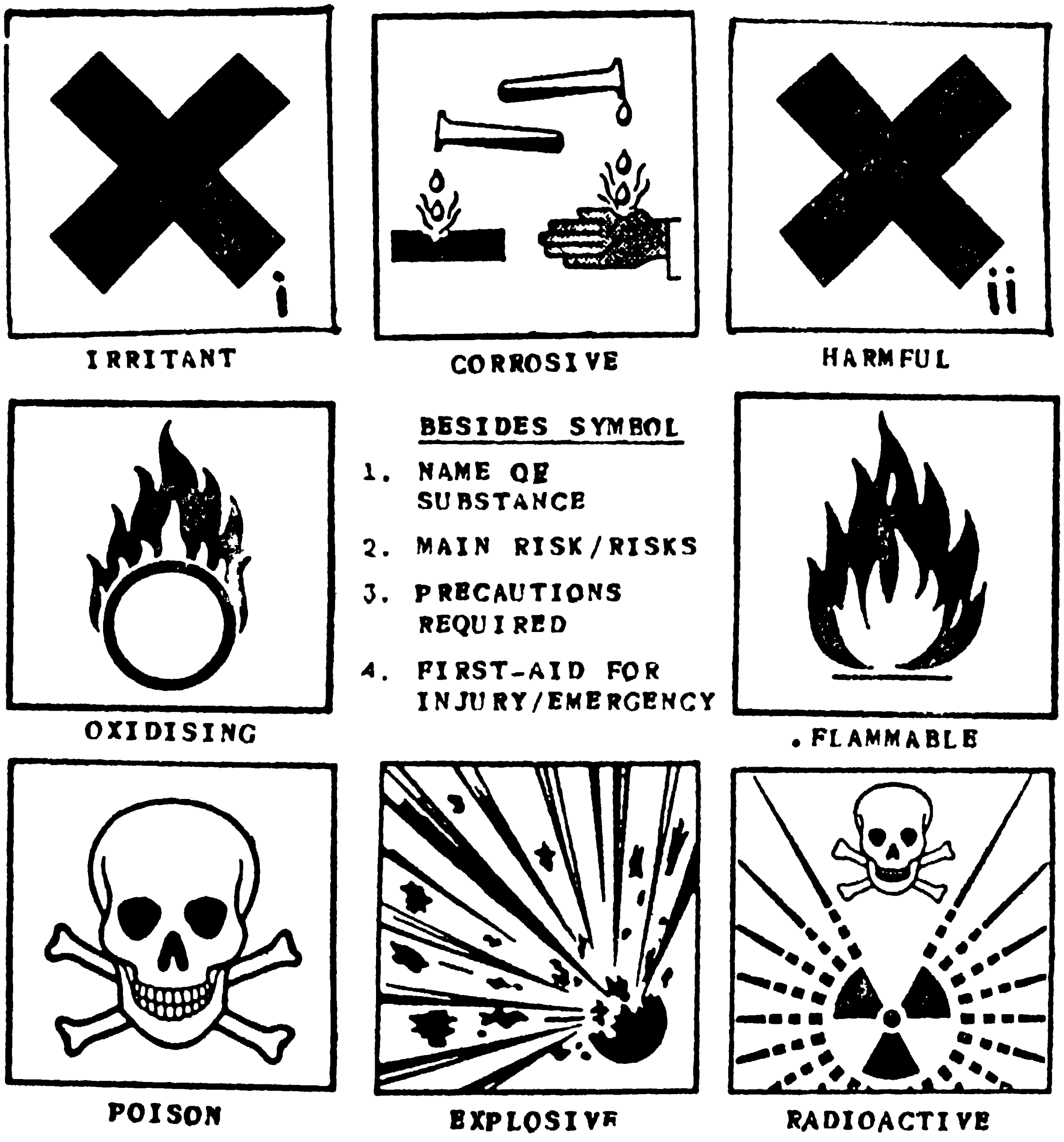

Fig. 1. Labelling requirements for safety, with symbols, for hazardous chemicals.

Notes and news

Workshop on Management of Disaster Planning

Disaster like flood and drought hits every year to some parts of India and specially in its eastern parts. Calamity in the form of loss of lives, properties, agriculture results from such havocs. Development of modern scientific technology even today is not capable of prevention of floods but definitely available technology will be able to prevent destruction of lives and properties With this purpose, the workshop has been organised during August 8-10, 1989 with the following objectives :

(1) To identify the areas in Eastern states commonly affected by disaster like flood ;

(2) To estimate the magnitude of the impact in terms of health and other health-related problems ;

(3) To consider the district-based strategic long- and short-term plans of action to be taken for health and other health-related problem due to flood ;

(4) To consider the anticipatory district-level advance action to be undertaken to mitigate the effect of such disaster ;

(5) To consider establishing a surveillance and monitoring system to know the impact the long-term effects and to take suitable measures ;

(6) Establishment of co-ordinating mechanism between Districts, State and Centre.

The areas covered by the workshop activities to achieve the objectives are :

(a) Status—paper presentation ;

(b) Health aspects of disaster management ;

(c) Planning for food and shelter in disaster situation ;

(d) Water supply and environmental sanitation management in disaster ;

(e) Veterinary health aspects in disaster ;

(f) Law and order and communication net work in disaster situation ;

(g) Meterological forecasting vis-a-vis management of disaster due to flood and drought.

The scientific session was designed to expose the participants first to the experienee and expertise of the expert scientist and then they were divided into groups assignments like pre-disaster management planning, management in disaster phase and post-disaster management.

The workshop was concluded with the adoption of the valuable recommendations which will be forwarded to the concerned authority.

The workshop was inaugurated by Ambarish Mukherjee, Minister of Environment and Forestry, Govt. of West Bengal. The Presidential Address was given by Minister of Waterways and Irrigation, Govt. of West Bengal, Debabrata Bandopadhyay. The Valedictory Address was given by T. C. Dutta, Chief Secretary, Govt. of West Bengal.

The workshop was co-ordinated by S. P. Mukhopadhyay, Head, Department of Preventive and Social Medicine, All-India Institute of Hygiene and Public Health, Calcutta from whom details of the workshop may be available on written request. □

S. P. Mukhopadhyay

Need for thrust to optoelectronics

Optoelectronics refers to the emerging field of technology where elements of optics, which make direct use of light waves, like lasers, light emitting diodes and optical fibres, are optimally integrated with electronic elements, like integrated circuits to achieve faster speeds and greater volume of information transmission, data communication and processing capabilities.

With rapid advances in electronics, in terms of increasing miniaturisation of electronic components, technology has reached its physical limits of speed of electronic transmission of signals, the fastest switches being those made of gallium arsenide semiconductors, with switching times of the order of 10 millionth of a millionth of a second. The aspiration is for even shorter switching times. The speed of light being higher in fact, the maximum attainable, there is every effort to make light or photons do what electrons were made to do till now. This has given rise to the usage of the term "photonics" because of the increasing role of light and optics in electronics.

In his opening remarks at the inaugural function, Prof. B. M. Arora, convener of a week long National School on Optoelectric Materials and Devices said that while we do have expertise in the country in fibre optics and semiconductors, the overall involvement to give a thrust to this important field of optoelectronic materials and devices has been, unfortunately, small. The purpose of the school, he said, is to bring together students, teachers, researchers in the laboratory as well as the industry and planners to initiate this process of involvement in an area which we could ill afford to neglect.

Delivering his inaugural address, Prof. Virendra Singh, Director of the TIFR, recounted some of the significant efforts made at the TIFR in the field of semiconductors and the role it has played in the growth of the field in the country, starting from the first TTL device that was transferred to the industry and conceptualisation of the Semiconductor Complex Ltd. (SCL) to the latest work in the area of new semiconducting materials and lasers. He hoped that the deliberations at the School would enable teachers from various universities and technical institutions to incorporate the current developments in optoelectronics in their regular teaching curricula.

To achieve the ends, several experts in the field, both from home and abroad, will conduct this week-long school. Apart from the several technical sessions that have been designed to highlight some of the latest developments in the field like integrated optoelectronics, quantum well lasers, novel optical detectors and epitaxial material growth techniques, the School will have two very important sessions one on the development of photonics in India and the other on safety considerations for semiconductor processing industry. The latter assumes significance in view of the complete devastation of the fabrication unit of the SCL, Chandigarh, early this year.

The School has been organised by the TIFR with support and financial assistance from the DoE, the Department of Science and Technology (DST), the ICTP, University of Bombay and the Indian National Science Academy (INSA). □

Excerpted from the Hindu

Financial Assistance to Scientists

The *Indian National Science Academy* invites applications from scientists for partial financial assistance to participate in important Scientific International Conferences abroad during the year 1990-91. Scientists interested to avail of financial support from the Academy for participation in International Conferences to be held during the year 1990-91 are requested to apply in the prescribed proforma. The proforma is available from the office of The Executive Secretary, Indian National Science Academy, Bahadur Shah Zafar Marg, New Delhi-110 002.

The scheme is operated under three different categories viz: (1) For International Conferences sponsored by the International Council of Scientific Unions (ICSU) and its affiliated bodies (ICSU Conferences); (2) For International Conferences sponsored by other agencies (Non-ICSU Conferences); (3) For applicants who are interested in partial travel assistance only, for participation in any International Conferences abroad. The applicants must be below 35 years of age. This is categorised as INSA-COSTED Travel Grant.

Category 1 : Scientist who has been invited to deliver a plenary lecture/preside over a session of a scientific conference or whose paper has been accepted for presentation, and who will also be provided maintenance allowance during his/her stay abroad and partial expenses by some agency, will be given preference over others. INSA's financial support, in case of selection is limited to a maximum of 50% International travel, 50% maintenance allowance for the duration of the conference and registration fee, wherever necessary. The prescribed application form duly completed should be despatched latest by January each year for consideration by a Committee of the Academy during the year.

Category 2 : Scientist who has been invited to deliver a plenary lecture/preside over a session or whose paper has been accepted for presentation and who will also be provided maintenance allowance during his/her stay abroad and partial travel expenses by some agency, will be given preference over others INSA's financial support in case of selection is limited to a maximum of Rs. 7,500/- only. Applications for this category should be received in the Academy for consideration three months prior to the date of commencement of the Conference.

Category 3: Under this category the scientist who is interested to avail partial travel assistance only, for participation in any International Conference and is also below 35 years of age may send his/her formal request on a prescribed application form atleast three months prior to the date of commencement of the Conference. The applicant should fulfill the following eligibility criteria before sending his/her application :

(a) His/her age should be below 35 years on the date of commencement of the Conference.

(b) He/she should hold a Doctorate degree.

(c) His/her paper should have been accepted for presentation.

(d) His/her local hospitality and partial travel expenses has to be borne by the organisers or some other agency.

Candidates selected will be supported partially for their travel cost, jointly by INSA and COSTED (Committee on Science & Technology in Developing Countries). The applications will be screened once a quarter during the year. □

Letters to the editor

Feulgen staining with modified nile blue and with an aqueous solution of Meldola's blue

In an earlier publication[1], it was reported that nile-blue reagent prepared with sodium hydrosulphite can be used successfully to stain nuclei following Feulgen hydrolysis. When prepared with 1N HCl and potassium metabisulphite, this dye-reagent produces erratic results. In a subsequent communication[2], it was reported that an aqueous solution of nile blue at certain pH is useful in the detection of DNA following acid hydrolysis of mammalian tissue sections.

Meldola's blue has not been used so far to stain DNA-aldehyde molecules. Its use in the staining of DNA-phosphate groups, after extraction of RNA selectively with cold phosphoric acid has, however, been reported[3]. The present investigation was undertaken with a view to (a) find out a suitable method of preparing nile blue and Meldola's blue reagents that would produce specific, uniform and reproducible Feulgen staining for DNA, (b) to eliminate the necessity of adjusting the pH of the nile-blue reagent which was essential in the earlier method of use of this dye or as an SO_2 containing reagent prepared with 1N HCl and metabisulphite and (c) to find out if Meldola's blue can be used in an aqueous solution to stain DNA-aldehyde molecules following Feulgen hydrolysis.

The dyes used were nile-blue chloride (E. Merck, C. I. No. 51180) and Meldola's blue (G. T. Gurr, C. I. No. 51176), both belonging to oxazine group. Nile-blue contains one primary amino group in its molecule and Meldola's blue does not. The two dye-reagents were prepared by dissolving 500 mg and 1.0 gm respectively of each dye in three separate lots of 100 ml of hot distilled water. To the nile blue solution was added 500 mg of citric acid and to the Meldola's blue, an equivalent amount of oxalic acid or citric acid. All the three dye-reagents contained 1.0 gm of potassium metabisulphite. These were added and then mixed very thoroughly and then filtered. The filtrate of nile blue reagent registered pH 3.2 and that of Meldola's blue reagents pHs 3.4 and 3.1. To another 100 ml of a 0.5% solution of nile blue were added 500 mg of citric acid and 700 mg of sodium thiosulphate. After thorough shaking followed by filtration, the filtrate appeared to pale-violet showing pH 3.2. To a separate 1% solution of Meldola's blue were added 500 mg of oxalic acid and 700 mg of sodium thiosulphate. After filtration, the filtrate appeared to be of ash colour when spread on a slide. This registered pH 3.5. An aqueous 1% solution of Meldola's blue was also used. The pH of this was 4.4.

The tissues used were liver, kidney, testis and thymus of a white rat that were fixed in 10% neutral formalin, Lewitsky, Helly, Bouin and platinum chloride-acetic acid[4]. Paraffin sections (8 μm) were used.

For staining, deparaffinised sections were subjected to the usual Feulgen hydrolysis, rinsed with water, stained with the different dye-reagents for 10 min, rinsed with water, treated briefly with 0.05 N HCl in some cases, rinsed with water, dried between folds of filter paper, treated briefly with n-butanol, cleared in xylene and mounted in DPX. In some cases, staining with the dye-reagents was also performed at 80°C.

Microscopic examination of preparations when stained with nile blue-SO_2 prepared with citric acid and metabisulphite revealed specific staining of the nuclei in all the sections of tissues fixed in the different fixatives. All the preparations withstood a brief treatment in acid water and could be dehydrated through ethanol grades. When stained with citric acid-thiosulphate reagent, staining intensity was somewhat less than was possible with the metabisulphite reagent. With this reagent, sections did not withstand even a brief treatment in acid water nor was it possible to dehydrate the preparations through grades of ethanol. Citric acid-thiosulphate under UV rays became reduced to almost pale-violet colour producing a complete negative nuclear colouration.

With Meldola's blue reagent prepared with oxalic or citric acid and metabisulphite specific staining of DNA-aldehyde molecules was not possible. Meldola's blue reagent revealed a change of colour from the original ash to a steel gray colour with a lack of ability of staining acid hydrolysed sections. Meldola's blue SO_2 prepared with oxalic acid-thiosulphate exhibited total lack of staining capacity. However, Feulgen hydrolysed sections, when stained with an aqueous solution of this dye, revealed perfect staining of the nuclei. Sections stained with an aqueous solution of this dye did not withstand even a very brief treatment in acid water. Even dehydration through grades of ethanol was not possible. However, preparations following staining when dried between folds of filter paper and then treated briefly with n-butanol revealed satisfactory colouration of the nuclei. Bouin-fixed tissue sections when stained with an aqueous solution of Meldola's blue revealed highly satisfactory and specific staining of the nuclei. Meldola's blue reagent prepared in any way was found to be non-specific even at 80°C. The shelf-life of nile blue-SO_2 is at least a week.

Kasten[5] studied the ability of various different basic dyes for the demonstration of DNA following Feulgen procedure. He also studied Feulgen staining property of nile blue-SO_2 and obtained inconsistent results with different batches of the dye. From his studies with the different dyes, he came to the conclusion that dyes for use in Feulgen procedure must have at least one primary amino group in their molecules[6]. Nile blue, however, contains one primary amino group in its molecule. But he did not recommend this dye for Feulgen staining. The ability of this dye in an aqueous solution for Feulgen staining was reported by the present worker[1]. It was also reported in that paper that nile-blue reagent prepared with sodium hydrosulphite can be used satisfactorily in Feulgen procedure. When charged with 1N HCl and metabisulphite, this reagent produced erratic results[1]. The present worker, however, chose citric acid to replace 1N HCl and the reagent contained metabisulphite. This reagent thus prepared produced specific and reproducible results in staining Feulgen hydrolysed sections fixed in the different fixatives. This does not mean that dyes without primary amino group cannot be used in the staining of DNA following Feulgen hydrolysis of sections. The author's previous publications[7-9] would substantiate this statement.

Regarding the ability of an aqueous solution of Meldola's blue to stain DNA-aldehyde molecules, it can be said that this dye is quite useful and gives specific nuclear colouration after acid hydrolysis of sections. Brief treatment in n-butanol following staining with this dye and drying between folds of filter paper, clearing in xylene and mounting shows the nuclei quite prominently. Thus, it is evident from this study that Meldola's blue (nephthol blue) of G. T. Gurr, without primary amino group in its molecule, is a highly satisfactory dye for the staining of DNA-aldehyde molecules following Feulgen hydrolysis of mammalian tissue sections.

The reason as to why preparations stained with nile blue-SO_2 or an aqueous solution Meldola's blue show leaching when treated with acid water or are dehydrated through ethanol grades is because the bond between the dye molecules and DNA-aldehyde molecules is rather weak. Therefore, following staining with these dyes, preparations are to be treated briefly with n-butanol. Thus, it is evident that the mechanism of staining acid hydrolysed sections with an aqueous solution of Meldola's blue and that stained with nile blue-SO_2 prepared with citric acid and metabisulphite is quite different.

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Received: 3 November, 1988.

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On a new stromatolitic horizon, south of Katni, District Jabalpur (Madhya Pradesh)

Previously unreported stromatolites have been observed by the authors while carrying out geological mapping of Bijawar and Vindhyan formations in north-east part of Jabalpur district near villages Gubrachari, Devrihatai and Salaiya about 16 kms south of Murwara (New Katni Jn.). This report discusses its significance in stratigraphical correlation and deciphering the depositional conditions of Bijawars around Jabalpur.

The Bijawar sequence in this locality comprises phyllite, dolomitic limestone, quartzite and chert breccia with some intrusives and extrusives. Feldspathic sandstone is the only rock representing Vindhyan Supergroup in this area. Dolomitic limestone is variable in colours like pure white, dirty white, yellowish-white, pink and grey. Present stromatolites are associated with either dirty white or gray coloured limestones. Under microscope the rock is microcrystalline to fine grained. It chiefly consists of anhedral granules (0.06-0.12 mm) of calcite and dolomite. The former, however, greatly predominates over the latter. They occur randomly distributed. The overgrowths of small grains often have developed sparry crystals (nearly 0.3 mm) disseminated in a homogenous mosaic. Small amount of quartz is found either as detrial clastic grains or those which are secondary replacing the carbonate minerals. Veinlets of secondary calcite and quartz (upto sizes of 2 mm) are frequently noted. Sometimes it also contains ovoid bodies similar to oolites but without any internal structures and therefore may be called intraclasts.

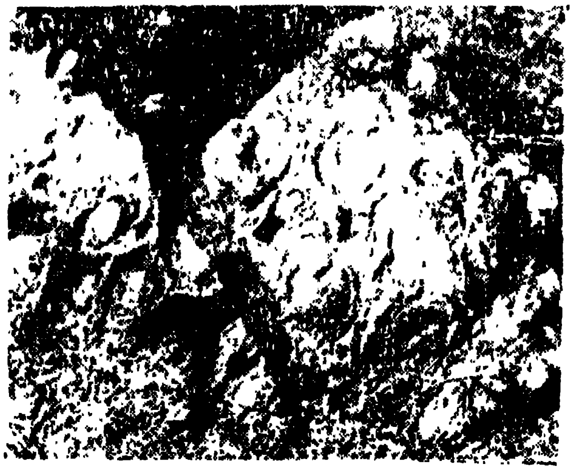

Fig. 1. Oncolites, near village Salaiya, note quasi-concentric structure (horizontal view).

This preliminary exploration has revealed important structures like variable sizes of oncolites (Fig. 1), cabbage-like form (Fig. 2), thrombolites[1], Cryptozoon Hall[8], Archaeozoon Matthew[8] and both simple and crinkled patterns of algal lamination. Oncolites, are typically spheroidal in shape and unusually large upto 15 cms of diameter with characteristic internal quasiconcentric structure. Similarly cabbage-like form is nearly 30 cms in diameter and display perfect concentric growths. Cryptozoon Hall are of mode characterized by overgrowth of concentric rings on nodular masses and that finally assume the ball (diameter approx. 10-15 cms) like structures. The laminations in the Archaeozoon Matthew are such that they form series of arcs and appear thickest on the side that faces upcurrent. The horizontal distances between the two consecutive throughs are approximately 20 cms.

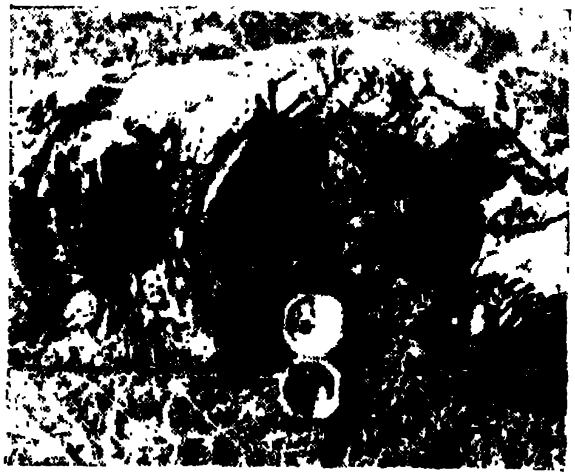

Fig 2. Cabbage-like form of stromatolite near village Gubrachari, note perfect concentric growth layers (vertical view).

TABLE 1 : **Chemical composition of stromatolitic dolomitic limestone**

Major oxides (wt %)		Trace elements (ppm)	
SiO_2	2.56	Pb	100
TiO_2	0.05	Zn	24
Al_2O_3	0.87	Ni	88
Fe_2O_3	0.01	Co	75
FeO	0.90		
MnO	0.02		
MgO	20.49		
CaO	29.70		
Na_2O	Trace		
K_2O	0.02		
P_2O_5	0.23		
CO_2	43.45		
H_2O^+	1.77		
H_2O	0.34		
Total	100.41		
CaO/MgO ratio	1.45		

CaO : MgO ratio of stromatolitic limestone is 1.45 (Table 1) which is much lower than upper Vindhyan 23.8, 18.7 and still lower than lower Vindhyan 1.8 averages, reported by Kumar[3]. This led to conclude that during the time of deposition of Bijawars magnesian salts of sea water were at much higher levels which gradually decreased in later periods with correspondingly increase in calcic minerals. Pb, Zn, Co values are also higher than lower Vindhyan stromatolitic limestones given by Kumar[3].

The presence of the stromatolites are indicative of very shallow water deposition of the Bijawar formation in this area, and even the crinkling shown by the algal laminations has been attributed to drying ; the water must have been exceedingly shallow, probably intertidal (Pettijohn[2]). Their association with oolites further suggests very shallow waters. Since the rock sequence has undergone polyphase deformation, and tight isoclinal to overturned folds have been reported by Das and Pandey[4], the upward convexity of these stromatolites provides significant clue to determine the top of the bed.

The authors are grateful to Prof. A. P. Agarwal, Deptt. of Geology, Govt. Science College, Rewa, for encouragement and Prof. P. S. Agarkar, Deptt. of Geology, Govt. Sci. College, Jabalpur for identification of stromatolites.

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Received: 9 May, 1988.
Revised : 16 March, 1989.

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Reversal of alar and cycocel induced retardation by humic acid in *Raphanus sativus* L.

Growth regulating chemicals viz., alar (N, N-succinic acid dimethyl hydrazide) and cycocel (2-chloroethyl trimethyl ammonium chloride) are well known for their effects on seed germination, growth and development of plants[1-3]. Exogenous supply of these growth regulators are known to interfere with the biosynthesis of pigments, specially chlorophylls and carotenoids[4], auxin metabolism[5,6] and gibberellin biosynthesis[3].

Humic acid (HA) is a water-soluble surface active phosphate ester, is reported to be auxin in nature[7] and is known to neutralise the growth inhibiting effects of several growth retardants[7,8]. The present investigation was aimed to lounderstand the role of alar and cycocel on seedling growth and pigment biosynthesis in *Raphanus sativus* L. and the reversal effect of HA.

The seeds of *R. sativus* were germinated under continuous light at 30 ± 2°C in sterilized petridishes lined with double layer of filter paper kept wetted with known amount of distilled water (control) or test solutions (HA 100 mg/l; alar 500 mg/l; cycocel 500 mg/l). A set of experiment was run simultaneously with a mixture of equal volume of 100 mg/l of HA with alar or cycocel solutions of 500 mg/l. These concentrations of alar, cycocel and HA were selected after preliminary trials. Three replicates of 20 seeds each were used for three sets of experiments. Observations were recorded after 96 hr. Dry weight of radicle and hypocotyl were taken separately after drying them in an oven at 80°C for 48 hr.

40 mg fresh cotyledonary leaves were extracted with 80% acetone and the optical density of supernatant extract for carotenoids and chlorophylls at 470 nm and 660 nm, respectively[9], was determined by using photoelectric colorimeter.

Alar and cycocel considerably inhibited the seedling growth, dry matter production and chlorophyll and carotenoid biosynthesis, while promotive effect was noted in HA alone. However, there was no remarkable difference in germination percentage. The inhibitory effects of alar and cycocel were nullified when applied in combination with HA. The linear growth of radicle and hypocotyl, dry weight values and optical density of extracted chlorophylls and carotenoids increased immensely, showing antagonistic effect of HA. However, the reversing potentiality of HA was not additive.

TABLE 1 : **Effect of growth retardants viz. alar and cycocel and humic acid alone and in combination on morphophysiological parameters in *Raphanus sativus* L. (96 hr old seedlings)**

Humic acid mg/l	Alar or Cycocel mg/l	Per cent seed germination	Length (mm)		Dry weight (mg)		Optical density	
			Radicle	Hypocotyl	10 Radicles	10 Hypocotyls	470 nm	660 nm
0	0	90.0	57.9	32.0	8.8	69.9	0.245	0.161
100	0	89.6	69.2	38.2	10.0	76.0	0.267	0.180
0	Alar 500	89.0*I*	48.6	21.8	7.5	56.2	0.226	0.134
100	Alar 500	88.5*I*	56.0	26.7	8.2	64.0	0.234	0.146
0	Cycocel 500	87.6*I*	45.0	20.2	7.5	53.4	0.214	0.140
100	Cycocel 500	85.2	54.6	26.7	8.5	64.0	0.231	0.154
	F	*	**	**	**	**	**	**
	C.D. at 5%	2.38	2.98	2.59	0.19	3.81	0.005	0.005

*level of significance 5% ; **level of significance 1% ; *I*insignificant at 5% level of significance

Though biochemical investigation will explain the mode of action of HA, but presumably[1] it can be said that HA at an early stage of plant growth acts as a supplementary source of polyphenols[10] which function as respiratory catalyst. In addition, HA also contain varying amount of nitrogen[10] which increases the metabolic activity of seedlings which were suppressed by two antimetabolites "alar and cycocel"[3] and thus facilitates the seedlings to grow.

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Received : 11 February, 1988.
Revised : 12 August, 1988.

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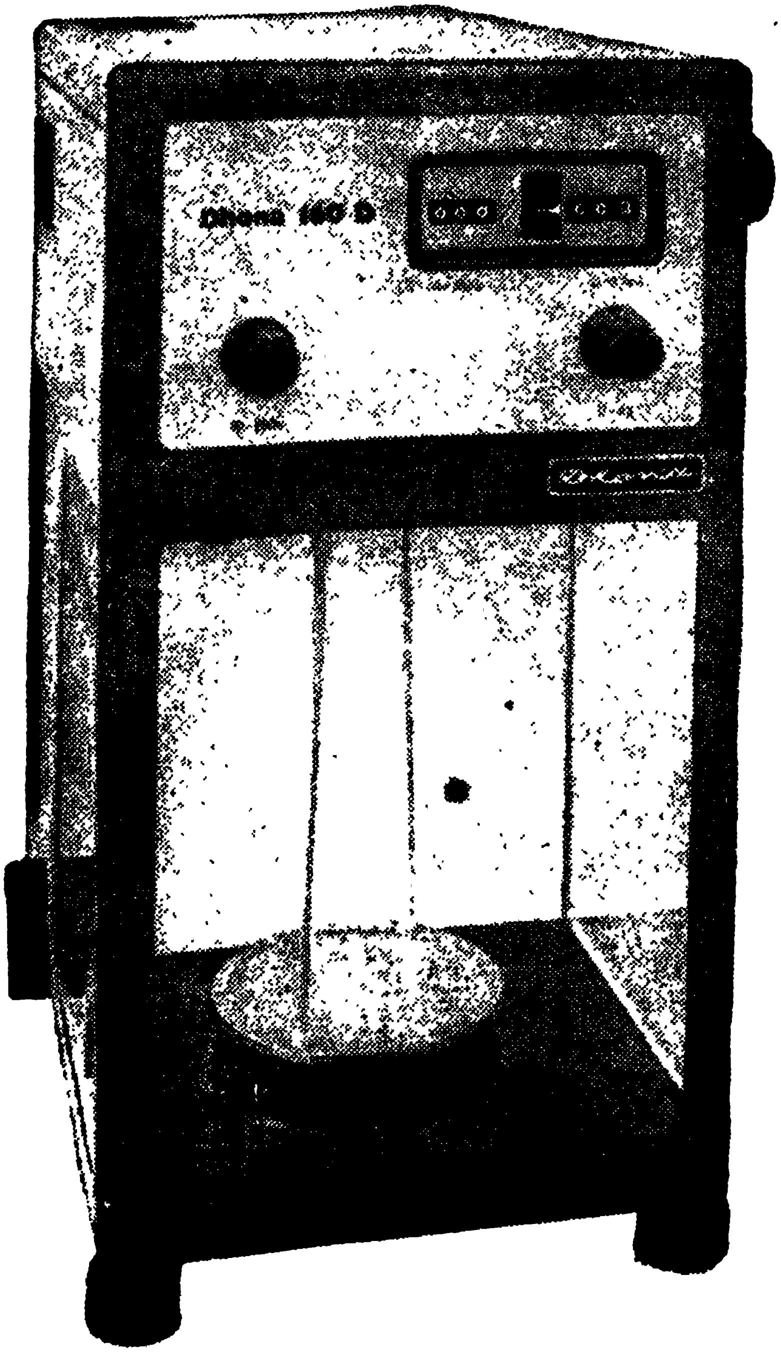

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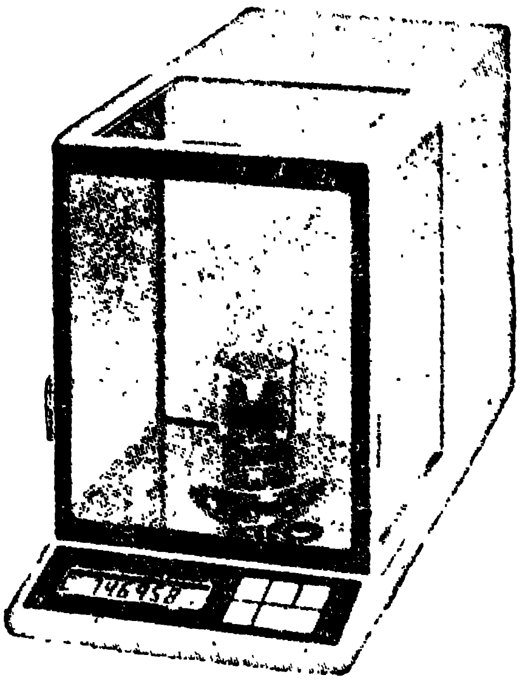

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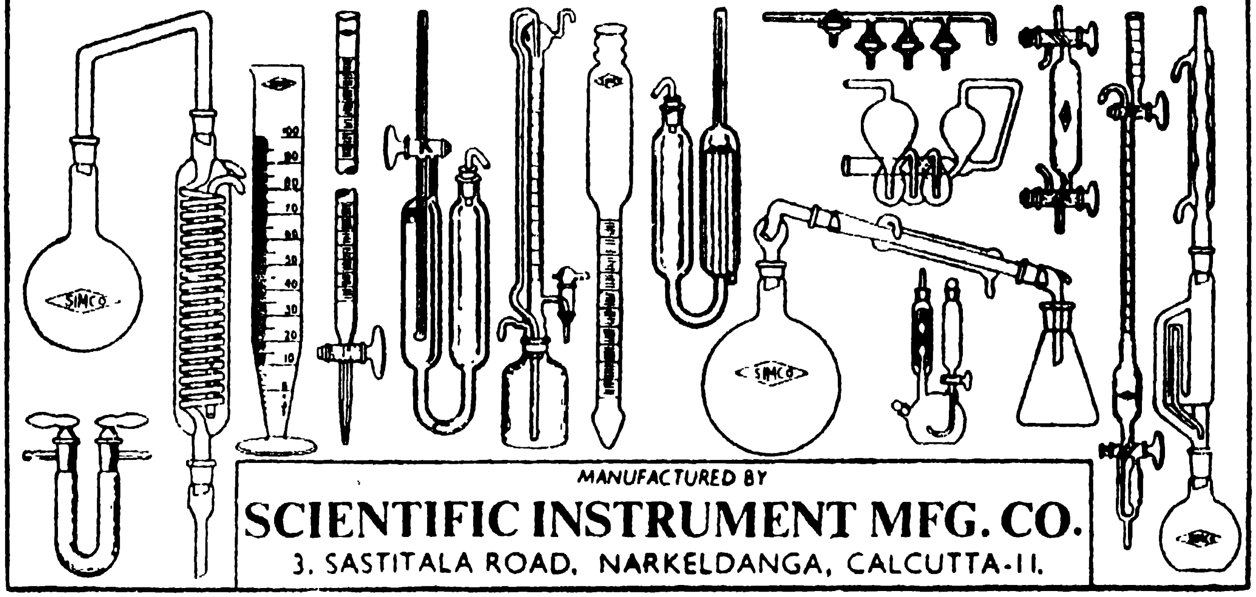

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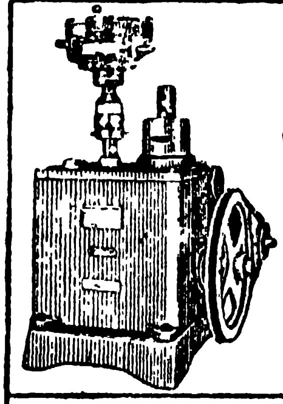

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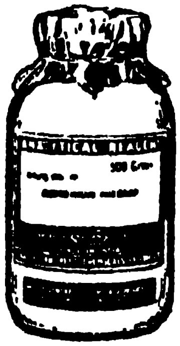

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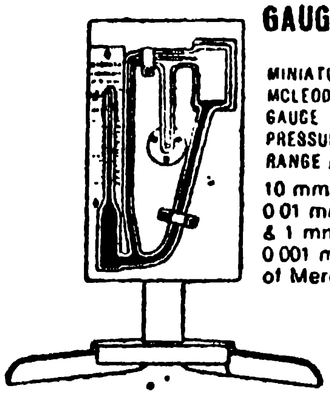

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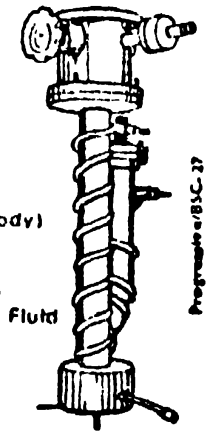

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October 1989 / Volume 55 / Number 10

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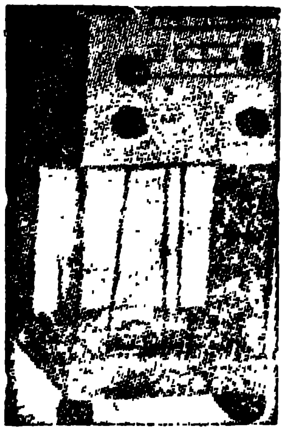

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SCIENTIFIC AND TECHNICAL EDUCATION

TO-DAY humanity is the greatest patron and greatest benefactor of Science and Technology which are the two most important components of economic growth of a nation and hence humanity is their greatest patron and benefactor. But science and technology cannot be grafted on a nation, their developments have to begin at the lowest level, namely that of science education in schools.

Application of scientific knowledge and technological skill has enabled man to meet all the necessities of his life and at the same time armed him with devastatingly destructive power which threatens the existence of life on the globe.

Education is a continuous process and its purpose is to acquire knowledge that helps to enrich the life of the individual and an awareness of his social responsibilities. It should be aimed at increasing intelligence, capacity for reasoning, development of personality and consciousness without any indoctrination to set views, ideas or ideologies, and science education is particularly helpful in this respect. Mere acquirement of knowledge of all the facts and concepts can hardly be a purposeful science education. It is very much important to inculcate in the young minds the spirit of inquiry and develop the skill for application of knowledge with a meaningful purpose for human and social welfare for which science has immense potentiality. Progress in technology based on scientific discoveries has demonstrated beyond all doubt the triumph of materialism. All the material well-being, health and security of man in the developed nations depend on skillful development and use of modern technology. But development and optimal use of technology has become a critical international issue and this is much more true for a developing country like India. However, it is essential to ensure that the students do not develop a misconception that science is purely materialistic and devoid of ethical and cultural values. An education which fails to enlighten the mind is totally useless. It is not the purpose of education to make man merely a storehouse of facts or turning him into a living machine of mechnical skill devoid of ethics, morality and rationality. Swami Vivekananda had rightly said, "Education is not the amount of information that is put into your brain and runs riot there undigested, all your life".

Teaching in modern science began in our country in the later part of the last century mainly through influence of western science made possible due to the advent of English under British rule in India. After independence in 1947 more intense efforts have been made to strengthen as well as to popularise scientific and technical education. But despite some progress the benefit to the nation has been far below expectations. Much of our meagre resources have been spent in setting up universities and other centers of so-called higher education, in building magnificent research laboratories in different parts of the country without any serious attempt to improve and strengthen science education in schools and even colleges which feed the universities and institutes. Thus we have followed a lop-sided policy of trying to erect a pyramid on its apex. Hence, even in scientific research our overall progress is not very encouraging both in terms of quantity and quality. According to authentic statistical reports the total publications by Indian chemists increased from only ca 0 5 to ca. 6 per cent of the total world publications during the two decades since 1960. Qualitywise the gap between Indian contributions in chemistry and that of the developed nations has widened considerably in the last four decades. The situation may not be very different in other branches of Science. In applied science also the position is no better. After independence a chain of national laboratories were set up in this country mainly for carrying out research in the application of science. While hundreds of patents have been registered by these various laboratories very few have been utilized or exploited so far by our industries. In course of time many of these laboratories have become more and more involved in duplicating academic works of the type carried out in our universities and institutions.

Because of our failure to improve the quality of education, particularly science education at school and college levels our science education in the universities has not improved but has infact deteriorated due to unplanned mushroom like growth and craze for university education. As a result we can say more appropriately what (late) Sir P. C. Ray said several decades ago that "most of our pupils come out of the portals of the university as no better than licensed ignoramuses". Most often the worst of these products are finding their way into the teaching profession and as such they fail to inspire and enlighten the next generation of students leading to a vicious circle and accelerating degeneration of the education system. One of the most essential needs for improvement of science education in the country is to train up a large body of most competent teachers thoroughly conversant with the modern concepts and principles of science as well as its moral and ethical values and dedicated to the ideals of the noble profession with a missionary zeal. They must have sufficient sense of proportion as to how much to teach. Some teachers in their enthusiasm teach too many things in too short a time without any concern as to whether this appeals to the students. Since there is so much to choose from, a successful teacher will select those topics which are closest to the questions already in the minds of the students. By their method and approach to a problem they must be able to kindle the spirit of inquiry in the students. It is only then that his teaching will be truly effective. They must be capable of initiating the young minds into the spirit and discipline of science and capacity for independent thinking. Members of our teaching community must try to keep them abreast with modern developments in science which is growing at a fast rate. They must organize regular discussions for improvement of science teaching in line with modern trends. However, the associations of teachers in our universities are now a days more concerned with their demands for the fulfilment of which they do not even hesitate to resort to the trade union practices of the non-teaching community. The teachers' associations hardly ever discuss academic issues at large such as restructuring of courses, innovative teaching, examination reform, etc. or launch any agitation for better infrastructural facilities in the universities that are most essential for science teaching. On the contrary they often join hands with opportunists and politicians demanding larger intake of students in post-graduate classes without any rational consideration of the available facilities and needs of the nation.

The failure of our science education would be apparent from another consideration. Many members of our scientific community who are quite well up in their scientific professional skill have superstitions of all sorts with firm belief in supernatural power devoid of any rationality and reasoning Infact, science and superstition coexist due to imperfection in science education. Rationality and reasoning are the essense of science which accepts only what can be proved and tested, and always ready to correct its mistakes on the basis of newly acquired facts and evidence.

The quest for new knowledge, new concepts and basic data constitute what is known as fundamental or basic research and the universities and research institutes are most suited for such activities. Basic research is rarely of use in the solution of immediate problems confronting a nation ; its relevance has to be judged in an entirely different context. Basic research of high quality has an important place in the university education system, since this leads to a tradition of independent, rational and penetrating inquiry which reinforces science teaching in the universities. Unfortunately most of the university departments in all the universities, barring a few, have in general rather poor facilities for good research work as may widen the frontiers of science. As a result individual research support to a few teachers to a limited extent by agencies like UGC, CSIR, DST, etc. fails to be truly productive as far as advancement of science is concerned. There is utmost need to considerably improve the infrastructure facilities in the university science departments but this is receiving little attention of our university administrators, and of the Government. In major research funding by different agencies in India to individuals and university departments we notice undue personal influence and patronage in supporting workers of lesser merit. Even men of talent, promise and proven ability are often subjected to considerable harassment, humiliation and hardship unless they butter some influential persons for patronage. For a change we have to develop a better value system and bring radical changes in our reward system. In the existing state of affairs most of our scientific workers are so agonised and consequently demoralised and frustrated that they can hardly enthuse the younger people to take up the pursuit of science as a career.

For improvement of our science teaching in the universities, restructuring of the courses is essential as also a radical change in the evaluation procedure. Fxperiment and observation are the two most essential basic needs of science education. But unfortunately the students do very little work in the laboratory that can help them to learn by practice what is taught in class-rooms. For example, in chemistry they are taught all the well-known spectroscopic methods and their applications, but as post-graduate students in our universities they hardly get a chance to gain first hand knowledge in these techniques in their laboratory work. The result is that they try to learn these techniques by rote without proper understanding. In chemistry most of what they do in qualitative and quantitative analysis in their laboratory work in the post-graduate classes are now obsolete in the advanced countries of the world and indeed serve little purpose in enabling them to acquire the desired skill needed for a professional chemist. It is indeed tragic that while we adopted the western system of science teaching when we started over a century ago, we have not changed much with the progressive and radical changes which have taken place in the west in course of time. The standard of teaching and research in science today in our country leaves much to be desired and we are far behind the progressive centers of the world in this respect. There are also rather wide variations in the standard and quality of science education in the universities in different parts of this country. No serious attempt has been made so far to bring in some amount of uniformity in the course structure and pattern of science education in the different universities. Even more demoralizing is the existing system of examination for evaluation of the students. In our existing system of examination we can hardly test the knowledge, capability and competence of a student.

Our science education at the college and university levels is far inferior to that of advanced countries due to lack of competent teachers, lack of the essential laboratory facilities and over crowding by too many students. The prescribed course structure is too rigid without any flexibility to suit individual needs. A common rigid science course at the undergraduate level in any particular science subject for those who intend to become scientists later in life and others taking up a general scientific profession is not suitable. But this is what our system provides and this common course is not helpful for either group. Even at the post-graduate level hardly any flexibility is allowed and the students specializing in a branch have to take up a fixed set of prescribed courses despite the fact that depending on the students' aptitudes and future aims a combination of courses may be more useful.

The present controversy as to what should be the medium of instruction is most distressing. For a vast country like India having a population of about 850 million who speak so many different languages in different regions there are inherent problems in imparting education at college and university levels in regional languages for which we notice almost a fanatic craze in many parts of the country. One obvious difficulty is the need to make available standard text books in different subjects in all the different languages. This would require serious efforts in translating well-known advanced treatises in English available at the international market, and also inducting competent men to write books of standard quality in the different Indian languages. The financial resources which would be needed for such an attempt to be successful is beyond our means, apart from any other hindrance. Indeed, the State Book Board in West Bengal took such a venture some years ago with little success so far. Whatever text books are available in regional languages through efforts of state agencies and some universities, their off-take is not satisfactory and text books in English are still, for very valid reasons, popular with students and teachers of the best universities and institutions in India. It is in realisation of such problems that in the education policy formulations of 1968 and 1986 a three language formula was proposed, to ensure good knowledge of English, Hindi and another Indian language (mother tongue for non-Hindi speaking people). It is not without reason that English has been proposed as a compulsory language to be studied by students going for higher education. Unfortunately in some places in this country, particularly in some of the Hindi speaking areas, there is strong resentment for English. The craze is so much that some universities make all correspondence in Hindi and this they do even for corresponding with an external examiner of a Ph.D. thesis although the thesis is written in English. This is hardly rational and reasonable. In the world today English is spoken as mother tongue by about 300 million people, while another about 300 million use it regularly as a second language, and the estimated number of people who are at present learning English as a foreign language—that is, in countries where English has no official recognition—is estimated to be over 1,000 million. English is the official or second official language in more than 70 countries or states in the world follwed by French (34), Arabic (22), Spanish (19), Portuguese (7) and German (6). Indeed it is through English that nations communicate with each other. The rising demand for learning English is quite spectacular, and more and more countries are turning to English as their second language. From October this year learning of Russian in Hungarian secondary schools has been declared as no longer mandatory, provided it is replaced by another foreign language. As a result the general preference has been in favour of English and the British Council, London, has been flooded with requests for teachers in English. Should we believe that all this craze to learn English is due to a lack of nationalist feelings in all these countries ? The answer is an emphatic "No" ; on the contrary it is due to the great advantage which English provides as a medium for international communication and international knowledge particularly in science and technology.

We must take a rational decision in the matter, without being swayed by passions and sentiments, as to whether it would really help us to discard English at least in the field of higher education in Science and Technology. By discarding English which has been and is still today the medium of higher education in science and technology in our country for more than a century we shall get completely isolated even in our own country—a Bengalee communicating with a Bengalee, a Tamilian communicating with a Tamilian and like wise for the other Indians speaking other languages including Hindi, apart from losing international contact. The idea that English may be learnt at a later stage by those who may need it is not a satisfactory solution. Linguistic capability decreases considerably with age ; moreover learning the language and not using it regularly cannot provide the desired skill for communication as is so noticeable with many distinguished men of science in Japan and the Soviet Union, particularly among the older generation.

Despite the fact that it will hurt the common popular sentiment I am strongly of opinion that if India has to go ahead in Science and Technology she must retain English in its rightful place in the system of college and university education and must also ensure that English language is well taught in schools beyond the elementary stage such that those coming out of our secondary school system have sufficient proficiency in English. Members of the academic community shall be failing in their duty if they do not make an honest confession and instead follow the dictates of the political leaders. At a recent conference held at Atarra Prof. Rawat of the Indian School of Mines, Dhanbad rightly said "If we do not speak the truth who else will" ? □

D. Banerjea

HIGH TEMPERATURE SUPERCONDUCTIVITY—EXCITEMENT & APPLICATIONS*

S. K. JOSHI**

I am grateful to the Council of the Indian Science News Association which chose me for delivering the Fifth Santanu Ghosh Memorial Lecture. It is a special occasion for me because this lecture symbolizes deep parental affection which Professor S. N. Ghosh and his wife Mrs. Shiela Ghosh had for their son Santanu who took a heavenly abode at a very young age of 21 in 1979. Santanu was a special child who fought bravely against a kidney ailment and was unusually creative as an artist. Since I know Professor Ghosh for about thirty years and had seen Santanu as a child, it is a special occasion for me associated with a lot of personal memories

In this lecture, I want to share with you my view-point about the excitement on applications of superconductors—especially high temperature superconductors I have preferred a qualitative description and have tried to make it simple for general understanding.

We surprisingly find a number of areas at frontiers of physics starting with "super" and you may call this as an 'era of supers' :

*Super*conductivity—high temperature
*Super*nova—1987A
*Super*conducting *Super*collider
*Super*computers
*Super*symmetry
*Super*strings

The discovery of high-temperature superconductivity has opened up before us a possibility of another industrial revolution which may have an impact as powerful and as widespread as that of the transistor revolution. Superconductivity as such is an old phenomena. It was in 1911 that the Dutch physicist Kammerlingh Onnes found that the electrical resistance of mercury cooled to 4.2K completely vanishes. This was a phase transition in mercury from a normal state to a superconducting state at or below a certain critical temperature, T_c. You can see that Superconductivity is a quantum phenomenon discovered before the birth of quantum mechanics. A superconductor is not only characterized by vanishing of electrical resistance but it also is a perfect diamagnet as pointed out first by Meissner. The Meissner effect implies that in the superconducting state the magnetic flux is pushed out of the superconducting material.

The special features of vanishing resistivity and perfect diamagnetism in superconductors immediately point towards the technological exploitation of superconductivity. The superconducting technology grew very slowly because of the limited domain of temperatures, current density and magnetic fields in which superconductivity exists. T_c, j_c and H_c i.e. critical temperature, critical current density and critical field are the limiting factors, so to say, barriers because of which the technology has yet not been fully utilized. For more wide-spread use one has to search for newer and newer materials with higher T_c Our progress with time in our attempts to increase T_c has been quite slow. This is shown in Fig. 1. It bears noting that on the basis of simple extrapolation we would not have expected these new high temperature materials with $T_c \sim 125$ before 2300 !

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* Santanu Ghosh Memorial Lecture delivered on February 27, 1989.

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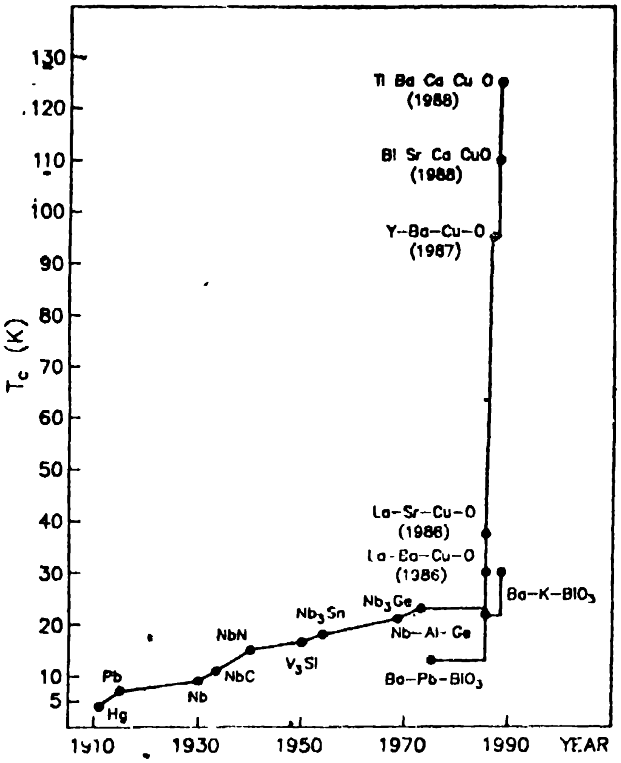

Fig. 1. Progress in superconducting transition temperature (T_c) since Kamerlingh Onnes' initial discovery of superconductivity in 1911.

It was the startling discovery of superconducting behaviour near 35K by Bednorz and Muller in 1986 in a mixed phase La-Ba-Cu-O, which changed the situation completely. The discovery electrified the whole world. T shot up in a dramatic fashion. A team lead by Paul Chu at the University of Houston reached T_c 90K in February 1987. 90K superconductor can be cooled by liquid nitrogen which boils at 77K and is cheap, easy to handle and plentiful. Research groups in India at the Indian Institute of Science, Bangalore, Tata Institute of Fundamental Research, Bombay, National Physical Laboratory, New Delhi, Indian Institutes of Technology Madras, Delhi Kharagpur and Bhabha Atomic Research Centre, Bombay began investigating the new high-temperature superconductors since January 1987. Professor C. N. R. Rao's group had studied some of these oxides materials which provide these new high temperature superconductors in seventies, but above their transition temperature T_c.

The main systems in which high temperature superconductivity is found to exist are given in Table 1.

TABLE 1 : **High Temperature Superconductors (n is the number of CuO planes for primitive unit cell)**

Symbol	Formula	n	T in K
La-Sr-Cu-O	$La_{2-x}Sr_xCuO_4$	1	36
Bi (n = 1)	$Bi_2Sr_2CuO_6$	1	10
Bi (n = 2)	$Bi_2Ca\,Sr_2Cu_2O_8$	2	85
Tl (n = 2)	$Tl_2Ca\,Ba_2Cu_2O_8$	2	105
Tl (n = 3)	$Tl_2Ca_2Ba_2Cu_3O_{10}$	3	125
Y 1 : 2 : 3	$Y\,Ba_2Cu_3O_7$	2	92
Tl 1 : 2 : 3	$Tl\,Ca\,Ba_2Cu_2O_7$	2	60

The structure of all these cuprates contain Cu-O planes. It is believed that oxygen holes in these copper-oxygen planes are crucial for understanding of the superconductivity in these systems.

With these developments, we come closer to the commercial applications of superconductivity. The advantages of the superconducting technology are that the efficiency is improved and the size of the product is reduced. In the case of the high-temperature superconductor, the additional advantages are that we can use liquid nitrogen as a coolant which is much cheaper than liquid helium in conventional superconductors and insulating a high-temperature superconductor would also cost less.

The key technologies for the superconductivity applications are : (1) film technology and (2) wire technology. In the case of the film technology, we deposit the film of the superconducting material on a suitable substrate by a variety of deposition techniques. Some of the main techniques used for film deposition are :

(1) Electron-beam evaporation ;
(2) rf sputtering ;
(3) Ion-beam sputtering ;
(4) Laser evaporation.

The substrates which are commonly used are alumina (Al_2O_3), MgO, Zirconia (ZrO), Silica (SiO_2) and strontium titanate (Sr TiO_3). The major hurdle which we face in thin-film technology originate from the anisotropic features in thin films, suitability of substrate, stability, lithography, passivation and multilayer deposition for making devices. As far as epitaxial thin films go, the situation regarding critical currents is satisfactory.

In the case of wire technology, the situation is much worse The critical currents which have been observed in bulk materials are too small to permit commercial applications. Efforts are afoot to attain higher critical current densities by overcoming intergranular boundaries. Anisotropy, stability and strain-resistance also present problems in using the wires for applications. Coatings suitable to give strength as well as stability are needed.

I shall now enumerate some of the applications of conventional superconductors. The applications of the high-temperature superconductors will come once the hurdles which I have mentioned above for the film and wire technologies are overcome.

Since 1960 high-field, high-current properties of type II Superconductors (Nb-Ti), (Nb-Sn) were used to construct wide range of high-field magnets for applications to medical imaging system, particle accelerators of high energy physics, fusion and MHD experiments. We have constructed an 8-tesla magnet at the National Physical Laboratory, New Delhi out of the Nb-Sn wire.

The magnetic resonance imaging is a new non-invasive diagnostic technology and is used for observing tissues within the human body. The intense, steady magnetic field produced by superconducting magnets shorten the exposure time and produce sharper images. Higher fields permit better resolution and finer focussing of scans on a particular element. This method is free from all harmful ionizing radiations.

Magnetically levitated train offers us a technological option for high-speed trains. Advanced prototypes of magnetically levitated train, using conventional superconductors, has been developed in Japan. The magnetically levitated Japanese prototype MLU 002 is undergoing testing on Miyajaki test track. The speed is near about 500 km/hr, nearly equal to the speed of an aeroplane. The superconducting magnets in MLU 002 perform functions of propulsion, vertical suspension and lateral guidance. The vehicle with superconducting magnets on board is propelled by mutual attraction and repulsion of magnets. Upon receiving the electric current from the substation, the ground coils laid on both the sides of the guideway turn into electromagnets which react with the superconducting magnets on the vehicle. As a result, the train is propelled. The polarities of the guideway magnets (energized with a.c. of suitable frequency) change repeatedly and are adjusted to be such that propulsion is guranteed.

The vehicle with superconducting magnets on board is levitated by repulsion of magnets. As the vehicle comes fast over the coils laid on the ground, these coils with electric currents induced in them, turn into electromagnets. One the lift off speed is achieved, the induced electromagnets repel the superconducting magnets so much that the vehicle is levitated.

Mutual attraction and repulsion of magnets is used to keep the vehicle with superconducting magnets on board at the centre of the guideway. In accordance with the instructions from the control centre, the substation supplies power to ground coils for propulsion after conversion to proper frequency and voltage matching the vehicle speed through the cycloconverter. Unlike the conventional railway, the magnetically levitated train involves no maintenance work such as replacing rails. It is a safe means of transport and runs at a super speed of 500 km/hr. Magnetic levitation eliminates noise and vibration.

The SQUID (Superconducting Quantum Interference Device), which is built from the Josephson junctions, is a magnetic flux detector of unsurpassed sensitivity. SQUIDs are used in study of neuromagnetism and as gravity-wave antennas. SQUIDs can also be used for mapping earth's magnetic field and interpret it in terms of natural resources buried underground. One simple application of a superconductor is a bolometer element of an infrared detector. The performance of such a device

TABLE 2 : Profits predicted from Superconducting Technologies by the year 2000

Application	Probability to be developed in coming 10 years	Predicted value in billions of Rs.
Magnetically levitated railway	Certain	60.00
Nuclear magnetic Resonance computerized tomogramy NMR-CT	,,	4.25
SQUID	,,	0.82
Compact cyclotron	,,	0.60
Large-particle accelerator	,,	0.24
Thin-Film target material	,,	0.11
Zero-resistance circuit boards	75-95%	11.20
Compact Sychrotron Orbit radiation (SOR)	,,	7.02
Magnetic-separation equipment	,,	1.68
Magnetic shields	,,	1.00
Electromagnetic Launching systems	,,	0.11
Ultraviolet sensors	,,	0.09
Large superconducting magnetic energy storage (SMES)	50-70%	30.35
Supercomputers	,,	17.20
Superconducting connections for LSI device circuits	,,	7.0
Motors	,,	0.70
Electric Power Generators	,,	0.50
Electric Power Lines	,,	0.30
Standard Voltmeter	,,	0.01
Magnetically propelled ships	Small chance	16.80
Superconducting LSI's	,,	3.56

is dependent on the heat capacity of the detector and liquid nitrogen operation cannot compete with liquid helium operation. Superconductors will be important in future computer technology even if new and unexpected developments do not take place.

New high-temperature superconductors offer wide variety of advantages. A great deal of material engineering needs to be done before full potential of these is realized. In Japan, scientists and industries are already thinking of a supercity based on superconducting technologies including

Superconductor motorship ;
Magnetically propelled aeroplane ;
Tubular magnetically levitated railway ;
Superconductive energy storage ;
Superconductive generators ;
Superconducting transmission ;
Superspeed computer and magnetic resonance imaging.

Nikki Industry Research Institute (NIRI) has completed a survey of potential impact of a viable high-temperature superconducting market and its effect on the global economy. The liquid nitrogen temperature superconductivity technology product market is projected to be about Rs. 180 billion/year. The probabilities of the product development and estimated production value in 10 years from now are given in Table 2.

One can, therefore, say that the superconducting technologies offer a lot of potential. In India, we need a positive and enthusiastic response from industry if we are to succeed in developing a few chosen technologies. Ways must be found to pursue jointly with industry pre-commercial development of superconducting devices and applications. ☐

EFFECTS OF PETROLEUM CONTAMINATION IN SOIL

MANAS RANJAN BANERJEE*

BACTERIA, filamentous fungi, yeasts and an alga are capable of obtaining energy and cell C from crude petroleum or its refined products. This relationship has been exploited in the use of microbes as sources of single-cell protein from paraffins as well as in studies on both the cleanup of oil spills and on the disposal of oily wastes by land spreading. During the last few years, a substantial progress has been made in describing microbially-mediated changes in the crude-oil composition and in identifying how problems of petroleum hydrocarbons in soil interfere with and can benefit from larger body of knowledge in soil microbiology, chemistry and physics.

Recent reviews have dealt with fats, waxes and resins, which occur naturally in low concentrations in soil and with soil-restoration following oil spills. The fate and effects of large amounts of petroleum-derived products in soil have been reviewed earlier[1,2]. Although the existing lists of organisms capable of hydrocarbon oxidation are not restricted to any particular type of organisms, the same appeared to be far from complete.

Consequences in soil

(1) *Physical characteristics*:

Initially, oil reduces soil wettability, but biological decomposition of the oil results in a return toward normal wettability[3] (Fig. 1). Soil microorganisms and fulvic acids have similarly been shown to reduce wettability. Decreases in soil wettability can lead to desication of surface soils on slopes and severe erosional problems. However, under field conditions, oiled coils which eventually take up moisture remain wet. Studies of a simulated oil spill (Table 1) clearly show that surface permeability increased as the content of oil increased[2].

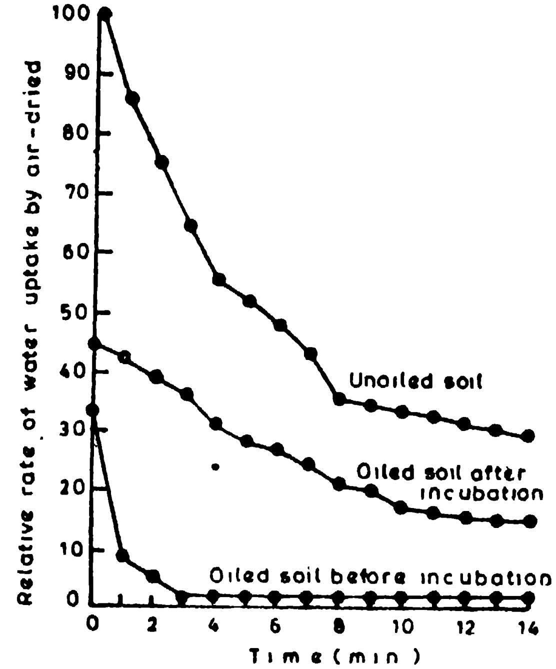

Fig 1. Wettability of oiled Angus Ridge Ap before and after incubation with 500 kg N ha^{-1} (N, P/K/S=10 : 2 : 3 : 1) for 6 weeks at 10°C.

In some instances, poor soil structure and wettability are not ameliorated after oil addition and treatment. The reasons are not clear. This may be due to a build-up of coatings of microbial cells over the soil particles. Poor wettability may persist due to lipid accumulation during oil decomposition under low soil N status.

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TABLE 1 : **Hydraulic conductivity of black chernozenic silty clay-loam soil contaminated with crude oil**[a]

Sampling Depth (cm)	K value (cm sec^{-1}) for different oil contents			
	0.0%	2.5%	6.1%	11.1%
0-15	3.0	4.4	6.3	9.4
15-30	4.0	3.7	3.2	8.2

Burning may create additional structural problems in the soil. Debano *et al.*[4] have shown that burning of organic litter results in the vaporization of hydrocarbon substances, some of which are translocated downward to form water repellant layers where they condense. Burning may be expected to raise the temperature of soil enough to kill off soil microbes, but this does not appear to occur.

Large amounts of oily material in soil will increase soil temperature by 1 to 10°C if the oil kills off surface vegetation[3]. Temperature-related diurnal variations in oil decomposition rates have also been observed in the field by Toogood[3].

(2) *Chemical characteristics* :

Several workers have noted that stable organic matter and total N contents of soils increase following contamination by petroleum oils. Increase in total N have been attributed to increased atmospheric N_2 fixation during the oil decomposition phase. Dinitrogen fixation during growth on methane has been reported for *Pseudomonas*[5] and *Methanobacterium*[6]. Increases in available P in soil saturated with natural gas have also been reported[7]. Oil has been found to both increase and decrease soil pH. Again, changes in redox potential, following petroleum oil addition to soil, appear to affect solubility of metals in oiled soils. Heavy metal accumulations from oily waste disposal may become a longterm problem. Jensen[8] has indicated that high Pb concentration may retard the rate of oil decomposition in soils. This may be important where soils are used for the disposal of used engine oils.

(3) *Biological characteristics* :

Measurement of microbial number, uptake of O_2, and release of CO_2 indicate that microbial activity is generally stimulated by the addition of petroleum hydrocarbons to soils[9]. Reported increases in bacterial numbers have ranged from slight to several orders of magnitude. It has been found that the effect amendments on the degradation of oil applied to field showed that the application of a fertilizer, containing N and P, resulted in an increase in the number of heterotrophic bacteria but in case of fungi that had not happened. However, the fungal population was affected by changing the nature of colonies. Changes in the nature of the soil microfaunal population have been observed after the addition of oil to soil. As out of 35 mycrobacterial isolates, only four grew on petroleum[10]. This may due to increase in number or due to change in the nature of colony.

Furthermore, all the allocthonous species had disappeared form the dominant microflora within 7 days after treatment, while the autocthonous bacteria showed a capacity for adaptation to the petroleum products which appear about 4 days after contact with the petroleum[11].

Among the bacteria, *Arthrobacter* and *Pseudomonas* are dominating the oil-decomposing soil whereas *Penicillium* and *Trichoderma* are the major fungi. A single addition of oil to soil does not seem to drastically affect the microbial population over a long time. Figure 2 shows the general pattern when oil is added to soil.

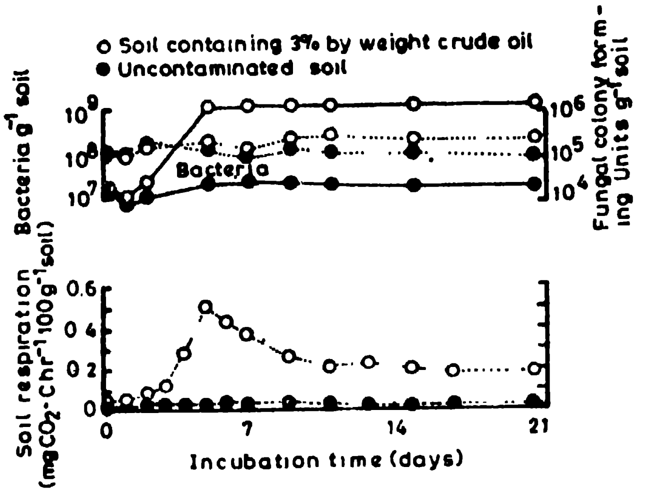

Fig. 2. Changes in respiration rate and microbial plate count incubated at 20°C with or without added crude oil

Denitrification during decomposition of hydrocarbon degradation products may be substantial due to low O_2 tension and high energy supply. McGill *et al.*[2] reported that NO_3^--N appeared to have a greater stimulatory effect on oil-spill site-restoration than did NH_4^+-N. The role of NO_3^--N as an alternate electron acceptor in oil contaminated soil has not yet been fully examined.

(4) *Plant growth and nutrient supply* :

Petroleum oil affects plant growth in several ways. The oil may directly kill the plant on contact or retard the growth that is already established, it may inhibit seed germination, create nutrient deficient conditions due to nutrient immobilization during oil decomposition, and it may, at low concentrations of hydrocarbons, actually stimulate the growth of plants.

Toxicity increases in the following order : Paraffins, napthalenes and olefins, aromatics. Generally within each group of hydrocarbons toxicity decreases with an increase in molecular size and increases with degree of oxidation. Fuel oil, less than 0.2% by weight to a depth of 60 cm, reduced yields of deep rooted crops. Normally larger amounts of crude oil

TABLE 2 : **Expected damage to plant growth and soil properties from contamination by crude oil**[1]

Oil content (kg/m^2 to 15 cm)	Proportion (wt % to 15 cm)	Effect on plant growth & soil properties
0-1	0-0.6	No visible damage to plants or soil, possible improved plant growth
1-2	0.6-1.1	Germination delayed; plant growth reduced; mildly nutrient-deficient; wettability of soil slightly improved
2-5	1.1-2.8	Germination inhibited; plants liable to serious nutrient deficiencies but growth can be sustained by careful management. Soil structure and wettability frequently very poor
5-15	2.8-8.3	Germination and plant growth severely reduced, soil structure and wettability very poor, residual oil must be biologically degraded before reseeding can be attempted
15+	8.3+	Soil soaked with oil, physical & biological reclamation measures needed before reseeding can be attempted.

in soil are needed to substantially reduce the crop growth. Hydrogen-sulfide toxicity to plants may occur following oil spills in poorly-drained soils.

Direct contact of oil with the seed appears to be necessary to markedly reduce seed germination. At low levels, heavy oils inhibited germination more than light oils. At high concentrations, the situation is reversed. Table 2 will show the relationship between oil content and damage to soil-physical properties as well as to plants.

(5) *Effects specific to natural gas* :

Many of the effects of natural-gas contamination of soils are similar to those produced by crude oil. However, the area contaminated is usually less. In small pipeline leaks, the gas spreads slowly by diffusion through an inverted cone-shaped soil volume and thence to the atmosphere. The rate and extent of spreading within the soil is dependent upon the gas pressure within the pipeline, soil-moisture content, porosity and the presence of fissures. Karia[12] has successfully approached for pollution abatement against the fuel oil gases at the Gujrat Narmada Valley Fertiliser Corporation Plant. Unlike crude oil, natural gas is not particularly toxic to plants. Most vegetation damage occurs indirectly due to a combination of low O_2 tension around the roots from the displacement of air and to the build-up of poisons such as H_2S, reduced Mn and Fe and N_2O under the anaerobic conditions produced by active microbial decomposition of the gases[1].

Though soil pollution by petroleum contamination is not yet a severe broblem in India, it is gradually becoming a burning crisis specially to the soils nearby the cities and industrially developed areas. In marine and oil-spill areas, the problem is becoming more acute. Indeed, the ever-increasing population of the world demands a greater production from agriculture and as almost all the arable lands have already been cultivated. We have got hardly any option but to reinnovate the problematic soils or polluted soils or low-yielding soils for obtaining higher agricultural production. It is thus that petroleum pollution in soil draws its significance. Marine soils and oil-spill soils are specially affected by this oil. To eradicate the crisis, the amelioration of these soils should be done with a view to maintain the ecology and microbiology of the soil for higher production with proper scientific and technological knowledge. The latter is yet to be evolved fully and satisfactorily. ☐

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FISHERMEN OF LAKE SONE IN ASSAM : THEIR SOCIO-ECONOMIC STATUS

S. C. DEY* AND DEVASHISH KAR**

ASSAM has 0.12×10^6 ha of lentic areas indicating tremendous potentialities of lake fisheries of the region. The activities of the fishermen and their socio-economic condition have been influencing the development and utilisation of its fishery resources in a significant way. The aspect has gained importance in view of the inferior social status and over-fishing of the lakes by these unprogressive, poverty-stricken people. The present paper purports an account of the socio-economic condition of the fishermen of Sone, a 3458.12 ha (at full storage level) tectonic lake in the Karimganj district of Assam.

Abounding fishermen of the lake

Thirty nine villages around the lake Sone contain fishermen belonging to four principal communities, viz., the Kâibârtâ, the Pātni, the Māimāl and the Nâmâsudrâ. An account of these communities is given in Table 1.

The fisherfolk of Sone have been categorised after FAO[1] into professional, part-time and occasional categories on the basis of their fishing intensity as purported is given in Table 2.

TABLE 1

Fishermen categories	Relative abundance (%) out of		Fishing area (hectare. fishermen^{-1})
	Total fishermen	Total inhabitants	
Kaibarta	68.14	47.67	0.32
Patni	14.66	10.24	1.51
Maimal	12.29	8.59	1.81
Namasudra	4.91	3.43	4.53
		30.07 (Non-fishermen)	

TABLE 2

Fishing category	Relative abundance (%) amongst				
	Kaibarta	Patni	Maimal	Namasudra	Total
Professional	55.04	6.91	5.54	2.51	70.00
Part-time	8.00	3.00	2.60	1.40	15.00
Occasional	4.50	4.75	4.75	1.00	15.00
TOTAL	67.54	14.66	12.89	4.91	100.00

Occasional fishermen

This group, which generally fish in the easily accessible shallow areas of the lake

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during the dry days either under compulsion or in commemoration of an event, constitute *c* 15% of the fishermen population of the lake. The time spent in fishing by each fisherman is shortlived as they fish mostly in a community in certain deep areas of the lake called "kuri" using simple and unproductive gears. Migratory habit is notably rare in this group of fishermen.

Part-time fishermen

This non-nomadic group of people, constituting *c* 15% of the fisherfolk population, fish only during part of a year and consider this activity as equal to or inferior to other activities of the group. The flood cycle, the biological cycle of fish (Welcomme)[2] and the seasonal needs of agriculture impose a cyclicity on such communities. As such, reservation of fishing sites is not practised by this group; rather, they generally prefer cultivation to fishing in shallow water. Although their interest lies in hauling large growing fish, the yield status is usually poor because of the lack of adequate knowledge of the distribution of fish species in the lake. They try to operate the major professional gears as well as practice some of the aquacultural techniques.

Professional fishermen

This is the largest group, forming *c* 70% of the fishing community, who fish in the lake throughout the year with the help of divergent types of fishing implements and methods. However, a tendency of concentrating to a few of the more sophisticated mechanised fishing methods is seen prevalent in them. Their catches consist of a variety of fish of different species and size, and also include a lot of juveniles. They are nomadic and live in temporary thatched fishing camps. They spend days together on boats and rafts while continuing fishing in the lake as well as in its inflowing and outflowing channels.

Socio-economics of the population

Although in India fishing is considered as a low category profession, it is the principal way of earning livelihood of the fishermen of the lake Sone. The entire area of the lake is used for intensive fishing on both domestic and commercial basis by different types of fishing implements (Table 3). Of these fishing gears, all but Pelâin are of commerical types. Jhākijâl and Pārân are casually found in domestic use as well. C.P.G.H. (catch person^{-1}. gear^{-1}. hour^{-1}. : Dey[3]) of the principal gears used by the fishermen (Table 3) and calculated on the basis of 12 month's moving average indicates that Dori is the most efficacious and is sequentially followed by Jhākijāl > Hârânjāl > Ghurānjāl > Pātānjāl > Châtjāl > Lār bârshi > and Mâhājāl. Use of fine-meshed nets involving catch of juveniles, which is seen in vogue in the lake, causes concern. Lack of proper training of the fishermen in professional fishing regulations appear plausible to such operation of banned nets in the lake. Further, in the absence of large-scale welfare measures embracing the improvement of the fisher-folk under report, they are forced to remain in the grip of the middlemen. Consequently, the per capita income (PCI) of the fishermen is low and ranges from Rs. 1.30 to Rs. 8.25 ($\bar{x}$ Rs. 3.83 ± 2.14). Their poverty is further aggravated by their early marriage and big family size. Low level of life expectancy (*c* 55 years) and high rate of child mortality (*c* 10% year^{-1}) also reflect their state of distress. Poor adult literacy (10-20%) may be considered as the

TABLE 3 : **Fishing gears operated by the fisherfolk of lake Sone in Assam with the CPGH of the principal gears**

Category	Gear (local name)	Average size (m)	Approx. cost of fabrication (Rs.)	CPGH (kg)
Hook and lines	1. Lār bârshi	L. 500	150.00	0.00051 ± 0.00024
	2. Kupā bârshi	L. 475	100.00	
	3. Tāngā bârshi	L. 400	200.00	
Traps	4. Dori	H. 0.75 W. 0.50	20.00	0.050 ± 0.021
	5. Pārân	H. 0,30 W. 0.12	5.00	
Trawls	6. Chhātjāl	L. 4.00 W. in front, 2.50	200.00	
	7. Pelâin	L. 2.75 W. in front, 1.50	30.00	
Scooping gears	8. Dhekijāl	L. 10.00 W. in front, 8.00	1,000.00	
	9. Dârārjāl	L. 4.00 W. 4.50	300.00	
	10. Kuchrungjāl	L. 1.40 Dia. 1.10	300.00	
Encircling gears	11. Mâhājāl	L. 725 H. 6.5	50,000.00	$0.000085 \pm 7.59 \times 10^{-6}$
	12. Dâljāl	L. 85.0 H. 3.0	3,000.00	
	13. Châtjāl	L. 115 H. 5.25	5,000.00	0.00054 ± 0.0010
	14. Ghurānjāl	L. 35.0 H. 5.25	2,000.00	0 0084 ± 0.0075
	15. Jhākijāl	L. 5.00 Dia. 4.25	800.00	0.024 ± 0.027
	16. Tānājāl	L. 55.0 H. 5.25	2,000.00	
	17. Rekhjāl	L. 5.25 Dia. 4.75	700.00	
Entangling gear	18. Pātānjāl	L. 350 H. 4.25	2,500.00	0.0019 ± 0 0011
	19. Hârânjāl	L. 5.5 W. of widest portion, 3.75	700.00	0.021 ± 0.0081

principal factor of their financial hardship. Juvenile literacy, though higher (*c* 60-70%), is soon followed by increased percentage of dropouts. Consequently, responsible earning members are very meagre and the levels of poverty linger on in the community. The fishermen now realise the gross imbalance which exists between poor income from fish trade and the hard labour put in. In view of this, there is a burgeoning tendency among quite a large number (*c* 59%) of the fishermen to motivate their children against taking up fishing profession. Consequently, it is found that only a meagre percentage (*c* 20%) of the youths wish to keep faith with their parental avocation of fishing. Others aspire for varied types of profession like banking, agriculture, defence, medical, engineering and teaching. As a remedy against such undesirable trend, a cross-section (*c* 12%) of their society advocates in favour of setting up of fisheries training institute in their area which would help making fishing profession attractive towards the youth.

During the trough season, when the lake shrinks to 409.09 ha and fishing becomes less intensive, fishermen cultivate Boro paddy within the lake to tide over the crisis. The area of their cultivable land ranges from 0.07–4.2 ha ($\bar{x}$ 0.2 ha ± 0.105). The Kaibartas possess the biggest quantum of land and Namasudras, the least while *c* 7% of the fishermen do not have any cultivable land. Nevertheless, some of them associate themselves during the offseason with livestock and poultry farming, pottery and carpentry, net and boat making and beverages. Some of the affluent fishermen, who possess big areas of cultivable land, raise the Sāli paddy in addition to the Boro and involve themselves in paddy trade in a big way. Besides paddy, they also grow vegetables and sungrass on a commercial scale.

Incidentally, religion forms a part and parcel of the daily life of the fishermen abounding the lake Sone. Among the Hindus, there are both Vaishnavites (*c* 33%) and Shaktas (*c* 30%). The Muslims, however, belong to one sect only. Being illiterate, the fishermen have peculiar beliefs about supernatural things.

Inference

The fishermen of Sone have been struggling against poverty since a couple of decades. In view of the nature of economic constraints faced by the fishermen, it is strongly felt that elimination of unscrupulous middlemen by organising credit facilities, marketing of product and purchase of domestic as well as production requirements through co-operatives would go a long way in the emancipation of the fisherfolk. Further, encouragement of Indian Major Carps (IMC) culture in the confined bundhs at the dead storage level of the lake would lead to a potential IMC fishery. Concomitantly, fast conveyance of the catch from the fishing centres to the fish landing stations and the urban markets would accelarate the fish trade. Provision of cold storage facilities in the landing stations and the urban markets would be an added advantage to prevent loss of flesh due to decay. Moreover, popularisation of the recent fishing techniques and proper rehabilitation of the fishermen will enable them to give up nomadism and cultivation in the event of hardship and help gear up the upliftment of the anglers in the long run. □

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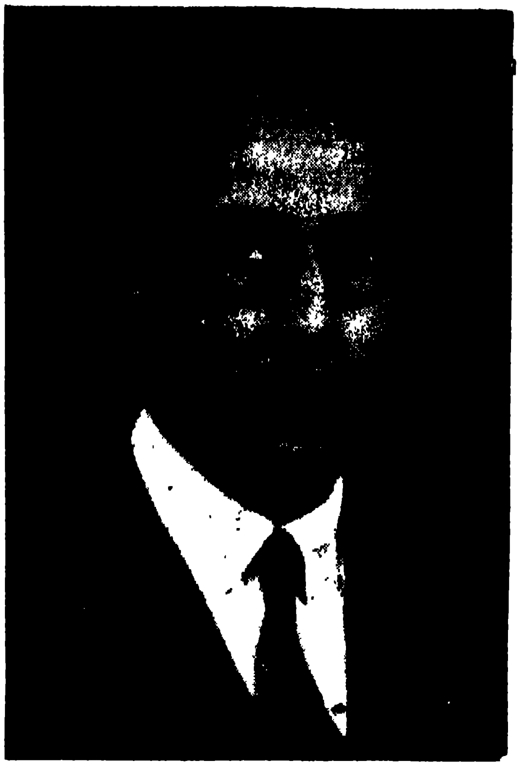

[October 24, 1989 heralded as the inauguration of the year long Birth Centenary Celebration of Prof. S. K. Mitra with a grand function and seminar at the University College of Science & Technology. Prof. Mitra was closely associated with the Indian Science News Association for a very long time and contribution to its developments were innumerable. The members of the editorial board hence decided to pay their humble tribute to this great soul by republishing Prof. Mitra's selected writing in the pages of 'Science & Culture' during this centenary year. A brief biographical sketch of Prof. Mitra as presented by Prof. B. R. Nag is also included for general information about Prof. Mitra.—*Eds.*]

PROFESSOR S. K. MITRA*

B. R. NAG**

SISIR Kumar Mitra was born on October 24, 1890 and this is the Centenary year of his birth. He joined Calcutta University in 1916 and remained with this University for 39 years till his retirement in 1955. Even after retirement he came to the University every day till his death. He was first the Khaira Professor and then the Ghosh Professor of Physics. After retirement he was an Emeritus Professor of the University.

Professor Mitra's early research interest was light. He earned two doctorate degrees, one from this University and the other from the University of Sorbonne for his research contributions on light and light standards. He had worked with many eminent scientists of his time including C. V. Raman, Fabry and Madame Curie. However, after obtaining his second doctorate degree his research interest changed. He chose radio science for further work and this remained his life-long interest.

Professor Mitra initiated study of radio science by introducing Wireless, as the subject was then known, as a special paper in the M.Sc. course in Physics and by starting research work on Atmospherics, night air glow and ionosphere. The school of research that he created earned international recognition in

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*Based on the Welcome Address given at the Inauguration of S. K. Mitra Birth Centenary Celebrations

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course of time and participated in all the major world-wide Ionospheric and atmospheric studies, such as IPY, IGY, MAP and others. His book 'Upper Atmosphere' became a bible for research workers all the world over. His outstanding research contributions were the theory of active nitrogen, the theory of f-layer anomaly and the suggestion of the interaction between the atmosphere and ionosphere.

Professor Mitra had a great foresight. He realised quite early, much earlier then many people even in advanced countries, that radio science and electronics was to grow and become the main vehicle of modern civilization. The subject, in his understanding, required much more intensive study than was possible within the scope of a special paper. He initiated a new department in 1945 to teach the subject as a separate discipline. This department also known as the Institute of Radio Physics and Electronics has trained hundreds of students who have been the leaders in academic institutions, research laboratories and electronics industries in this country and also abroad. When starting the new department Professor Mitra saw to it that study of all branches of radio science was pursued. Researches were organised under his direct supervision on vacuum tubes, transistors, antennas, microwaves, electronic circuits, radio astronomy, communication and computers. Ionospheric studies were also strengthened by building a field station at Haringhata. In recognition of the consequential developments the Department of Radio Physics and Electronics was selected for starting a Centre of Advanced Study by the UGC in 1962. Prof. Mitra had retired by then, but he continued to be the guiding soul of the Centre so long as he was with us.

We remember Professor Mitra as the creator of Radio Science in India, not only in academic institutions but also in industries. In the very early days he had constructed a transmitter for amateur radio broadcast. As the chairman of the radio research committee he initiated activities for the indigeneous manufacture of radio receivers. He supervised in his own laboratory the construction of loudspeakers, microphones and vacuum tubes. The first diode and triode in the country were constructed in his laboratory.

Professor Mitra taught and did research when the country was ruled by the British, who were not much enthusiastic about such activities in India. Conditions have changed after we won our freedom and a scientist today is backed by the Government and the people. But, it is hard to find in the developments in post-independence India the zeal, determination and love for the country that guided our great scientists like Professor Mitra. ☐

SCIENCE AND CULTURE*

S. K. MITRA

ONE of the objects of this Association is to popularise science, that is, to bring within easy reach of the general public information about the facts and discoveries of science. The ordinary man has a longing for such information; he wants to know of the latest advances in the different branches of science and of their technological applications. This popular demand we have been trying to meet by publishing in our journal, *Science & Culture,* over more than two decades, articles written by distinguished scholars from all over India. We have also, in many of our articles, particularly those in the past from the powerful pen of the late Dr. M. N. Saha, tried to impress upon the then government, the importance of science in the economic development of the country and of the urgency of starting the basic industries—industries which we find today included in the public sector of the Five-Year Plan. As a matter of fact, the very idea of economic planning after the pattern of the U.S.S.R., the idea that by such planning only the living standard of a backward agricultural country like ours can be raised, was first mooted vigorously in the pages of *Science & Culture.*

For all these achievements we may justly claim some amount of credit. But we shall be failing in our duty, if, after 22 years of our existence, we do not ask ourselves. How far our journal and our organization have been successful in our prime objective, namely dissemination of scientific knowledge and information to the general public. I have spent some thought over this question, and, my finding is that we have not succeeded to the extent we had hoped for. Also, part at least, of the responsibility for the failure rests with us. The articles we publish are not always what may be termed popular. More often than not they are too technical, fit only for consumption of the specialist in the subject. I hope the Editorial Board will take note of this and give due consideration to this very important matter. If we want to reach a wider circle of readers, we must make our articles really popular. I do not think it is difficult to secure such articles. What is needed is proper directives to the writers of the articles.

But, this fact apart, there is also another and more fundamental cause of our failure to reach the general public to which, in fairness to ourselves, I must also refer.

Attempts at popularisation of science and dissemination of scientific information cannot be successful unless the reading public has specific training in scientific method—in howsoever an elementary or simplified form that might be. And, this training, if it is to benefit the largest section of the populace, must be imparted at as early an educational stage as possible, at least, not later than the school stage. The ordinary man, as I have said, may have some sort of longing for understanding science. But, unless he is aware of the basis upon which science rests little is to be gained by trying to feed him with detached bits of scientific information through so-called popular science articles.

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*Being the Presidential Address at the Twenty-second Annual Meeting of the Indian Science News Association, held at Bose Institute, Calcutta on September 18, 1957.

Unfortunately, in our country, there had been, for a long time, no provision for imparting basic training in science in the schools. In so far as the State of West Bengal is concerned, it was only just before the Second World War that science found a place in the school curriculum as an optional subject only. For lack of funds very few schools could offer facilities for this course It would surprise many to know that teaching of elementary science, or what is described as General Science, has been introduced on a compulsory basis only in the current school session in Class IX, and that as a half-paper only. However, it is proposed to introduce it as a compulsory course, as one full examination paper, if not from 1958, from 1959 at the latest, in all Class X schools. It is already so in the newly organised Class XI schools.

I would hasten to add here that there are other weighty reasons also—besides helping popularisation—for which science should find a place in the curricula of the early stages of education.

Early Introduction of Science Teaching

The first and the most important of these is that scientific knowledge, in recent years, has been advancing rapidly and the future of civilisation depends upon our developing more and more a scientific habit of mind. It will be nothing short of criminal to keep back, from any section of the young people with growing mind, the knowledge of the method by which these advances are being made and thus denying them the opportunity of developing this habit of thinking. It is, therefore, now an accepted principle that the liberal general education which precedes diversification should be balanced by including in the course, along with the subjects in the humanities group, those which lead to an acquaintance with the principles and laws of science.

There is another reason also allied to the above. According to the recommendations of the Mudaliar Commission on Secondary Education—which recommendations are in course of being implemented in the different States—the secondary education is to be so planned that it is a complete unit by itself. It is not to be regarded as only a preparatory stage for a university career. A student even if he has not had the advantage of university education is expected, on the completion of the School Final Course, to be familar with the world he lives in, able to adjust himself to his environments and also understand the impact of science and technology on society. A course on general science thus becomes essential in the secondary stage.

One other reason may also be added. A general course on science in the stage will help the students in making a choice of their future career; choice between arts and science. It may even help him to find out whether his leanings are towards pure science, towards technology—the art of finding new applications of the scientific discoveries, or towards engineering.

In the ultimate analysis, however, the best and the simplest reason that may be advanced in favour of the inclusion of science in early educational stage is that scientific education is to be regarded as a part of cultural education, because, science is a creative Art; laws of science are creations of the human mind in its attempt to understand Nature. Our ancient cultures are being threatened today because their foundation is not receiving the life-giving support of a scientific habit of mind. Our future also—in these days of atomic weapons and inter-continental ballistic missiles—will be dark unless we have a balanced and unified culture aiming at a symbiosis of Science, Art and Moral Philosophy. ☐

Reprinted from October 1957 issue of *Science & Culture.*

Notes and news

Test-tube birth in Calcutta

Dr. B. N. Chakravarty, the renowed gynecologist in Calcutta did a successful experiment with test-tube birth for the second time in Calcutta very recently. His first successful experiment was carried out in 1986. The baby was born at CIT Road on November 19, 1986. This time a boy was born with experiments conducted at the Institute of Reproductive Medicine at DD 18/571 Salt Lake, Calcutta.

Research on test-tube birth had a long history. In 1944, John Rock and M. F. Menkin of the Harvard University Medical School in USA started work on test-tube fertilisation. They obtained mature eggs from the female patients and exposed them to a sperm in a test-tube. But they did not proceed further. It was only in 1952, Landrum B, Shettles of the College of Physicians and Surgeons formulated a culture medium in which the eggs could mature and be made for fertilisation.

This time Dr. Chakravarty employed a nutrient medium HAMS F-10 to keep the ovum from a female and the sperm of the husband. He put the inactivated maternal serum in this medium and heated it to 56°C. At 10% of HAMS F-10 solution in water, fertilisation starts, he reported. According to him, growth takes place at 20% and implantation or transfer occurs at 50%.

The specialities in test-tube birth lie in the fertilisation of a mature ovum by sperms outside the body instead of that occurring in the fallopian tube which transport the released ova to the uterus. But blockage in the fallopian tube obstructs it. Difficulty arises for want of healthy sperms too. The new technique is helpful for married couples who have no children.

According to Dr. Chakravarty, an ovum in a test-tube starts dividing immediately after a fertilisation. After 48 hr, he said that it reaches a stage with many cells called blastocyst when it can be taken out of the nutrient medium and implanted into the uterus of the mother. The rest of the stage is similar to the normal procedure for the human embryo to grow for the full term.

Sometime implantation presented some problem. In the initial trials, many volunteers using the technique became pregnant but miscarried within a few weeks of implantation. The problems were subsequently overcome.

According to Dr. Chakravarty, if the ovum is good, there is nothing to be done and there is no difficulty. In the test-tube experiment for the present instance, there was no problem of miscarrying soon after implantation, he said. The painstaking research of Patrick Steptoe of Oldham Hospital in North England and of Robert G. Edward, the Cambridge physiologist also led to the test-tube birth of a baby of Brown family.

In order to isolate mature ova at the right time, hormone injections are also given, if required, to the volunteers to control their ovulatory cycles. Dr. Chakravarty revealed that these two injections include HMG (Human menopausal gonadotrophin) and HCG (Human chorionic gonadotrophin). □

P. C. Bhattacharyya

Birth Centenary of Prof. S. K. Mitra Celebrated

The inaugural function for the celebration of birth centenary of Professor S. K. Mitra was held on October 24, 1989 at the auditorium of Saha Institute of Nuclear Physics. The function was inaugurated by Dr. A. P. Mitra, F.R.S., Director General of C. S. I. R. and chaired by Prof. B. Raychaudhury, Vice Chancellor, University of Calcutta. The welcome address was given by Prof. B. R. Nag. It was announced that the celebrations will continue for the entire year and many more functions will be arranged. The inaugural function was followed by a seminar. The speakers and the topics of their lectures were :

Dr. K. Kasturirangan, ISRO Satellite Centre, Bangalore, "Some New Directions in Space Research".

Professor S. C. Dutta Roy, I. I. T., Delhi, "From Cercuit Theory to Neural Network".

Dr. J. C. Bhattacharyya, Indian Institute of Astrophysics, Bangalore, "Different Astronomics : Indian Endeavour".

Prof. S. S. Baral and Prof. M. K. Dasgupta spoke on the life of Prof. S. K Mitra. □

Subsurface drip irrigation for field crops

Field tests and experiments conducted over the last five years have demonstrated the technical feasibility and economic advantage of trickle-irrigation systems, installed permanently below the surface of the soil. This technology results in larger crops, reduces water consumption and makes the utilisation of water from non-conventional sources possible and also yields significant savings in cultivation costs.

Scientists from the Sde Boker Desert Research Institute's Salinity and Water Engineering Unit and from the Ramat Hanegev Experimental Field Station installed networks of 12-mm plastic irrigation pipes, either 96 or 192 cm apart; each pipe was equipped with dippers at one-metre intervals, rated at two litres per hour each. The entire system was buried at a depth of 30 cm.

In course of these experiments, cotton, maize and wheat were cultivated during five consecutive seasons and all reacted favourably. With due attention to the optimum distance between laterals, production went up as much as 25% and compared with control areas wanted by surface drippers.

The purified sewage water is delivered directly to the root systems so that the surface of the ground always remains dry. That not only makes it possible to move across the field at all times; it also reduces weed growth and avoids problems of public health which are likely to be caused by irrigation even with treated municipal effluent.

Most significantly, the laterals and drippers were found to function satisfactorily year after year even though they were buried. Drip emitters were not observed to clog to any significant extent. On the other hand, damage caused to surface-irrigation lines by ultraviolet radiation by animals and birds was avoided. ☐

News from Israel

BOOK REVIEWS

Biofertilizers: Potentialities and Problems. Edited by S. P. Sen and P. Palit. Published by Plant Physiology Forum, Calcutta in association with Naya Prokash, 206 Bidhan Sarani, Calcutta-6. Printed at M/s Glory Printers, Calcutta-9, 1988. Hard cover, cloth bound with a glossy jacket. Pages 263, 15 cm × 22 cm. Price : Rs. 250

In some form or other, biofertilizers have been used traditionally in most countries of the world for the improvement of agricultural soil. With the rise in the cost of chemical fertilizers and understanding of their pollution hazards, the biofertilizers have attracted renewed interest during the last two decades. Biofertilizers are comparatively cheaper and safer. Not only they supply essential nutrients to plants, but also at the same time improve the quality and tilth of the soil. There is a positive need for promotion and popularization of biofertilizers, particularly in the poorer agricultural countries like India. The book is a source of valuable authentic information on the subject.

The volume is a collection of scientific papers presented in a national symposium organized by the Plant Physiology Forum, Calcutta at the Bidhan Chandra Krishi Viswavidyalaya in December, 1986. It contains altogether 32 articles besides the inaugural address and the key note address delivered by A. B. DasGupta and S. K. Mukherjee respectively. The volume is enriched by several comprehensive reviews made by pioneering specialists. The contributions dealing with various aspects of biofertilizers are broadly divisible into three subject categories: legume-rhizobium symbiosis, diazotrophic cyanobacteria including *Azolla* and associative symbiosis between plants and micro-organisms. Among the contributors are such renowned scientists as N. S. Subba Rao, R. Tuli, P. N. Bhaduri, G. S. Venkataraman, S. P. Sen, P. K. Singh and others.

The collection provides the reader with an opportunity to have a glimpse of the latest developments in the field of utilization of microbes for the improvement of crop production. Necessity of such a collection of information had been felt for a long time, because with the increasing importance of biofertilizers in agriculture, feeding of information to students and researchers became inevitable. The book has fulfilled this need and will undoubtedly serve as a handy source of information on biofertilizers to agricultural scientists, biotechnologists, microbiologists and to the teachers and advanced students in universities.

The get-up of the publication, including printing and binding is of high grade. Special care has been taken to avoid printing errors. The price seems to be a little too high for the common reader. □

A. K. Banerjee

The Useful Plants of India, Publications & Information Directorate, C. S. I. R., New Delhi, 1986. (Price : Rs. 128, $ 32 or £ 24)

The first edition of the Wealth of India (*WI*)—Raw Material Series—embraced eleven volumes and two supplements, taking into account the Indian raw material of animal, mineral and plant origin. This edition was welcomed both in India as well as overseas countries as an outstanding and unique reference work of its type. The present treatise contains in capsule form the salient information on plants of economic importance dealt with in the volumes on *WI*.

Within 916 pages (text : 705 pages; index : 211 pages), an amazing amount of information concerning roughly 5,000 species have been packed. Whereas the book is principally based on *WI*, information has also been drawn from two sources—*Glossary of Indian Medicinal Plants* and its Supplement by Chopra *et al.* and the *Dictionary of Economic Plants* by J. C. Th. Uphof. The plants are listed in alphabetical sequence of their scientific names followed by their families and vernacular names. For the convenience of the users, cross-references of all botanical synonyms have been given for each entry. The comprehensive index comprises names in Indian languages, common English names and regional and trade names.

Certain glaring demerits of the present book deserve to be mentioned. Attention has not been drawn to the habit of the plant, areas of distribution/cultivation and the chief uses such as for drugs, dyes, fibres, food, timber, etc. Wherever possible, the centre of origin has not been indicated. In the end, there is no bibliography of source-material from which one can gather further information. In this respect, I consider the *Dictionary of Economic Plants* by Singh, Wadhwani and Johri (2nd edn., ICAR, New Delhi, 1983) to be a better book to use in and easy to pay for (Rs. 20) compared to the current highly-priced compendium.

The present book would be undoubtedly useful to students and research workers, especially those interested in agricultural botany, horticulture and economic botany. It is worthy to note that economic botany is taught at the undergraduate and postgraduate levels in the Indian universities. □

S. C. Datta

Letters to the editor

Effect of metal ions on growth of three strains of Gymnoascaceae

Trichophyton and *Microsporum* are well-established pathogens. *Rollandina* has been isolated from clinical as well as saprophytic sources. Contaminated soil such as garbage sites, sewage system with high percentage of animal excreta such as hair, nail, hoof, etc. serve as reservoir of such organisms. They become parasites by accident[1]. These organisms belong to the family Gymnoascaceae. The micro-element requirements of six other species of the family has been studied earlier[2]. The aim of this paper is to study the effect of several micro-elements and heavy metal ions on three strains e.g., *T. rubrum*, *M. gypseum* and *R. capitata*. The toxicity of the heavy metal ions may be used to check the growth of the organisms which are the results of environmental pollution.

Rollandina capitata pat. (strain NRRL 5998) was obtained from American Type Culture Collection, Rockville, Maryland, USA and the strains of *Trichophyton rubrum* (Castellani) ST-849-81 *Microsporum gypseum* (Bodin) Gulart and Grigorakis ST-676-81 were isolated from lesions of the patients at the School of Tropical Medicine, Calcutta (India). The strains were maintained in potato-dextrose-agar. To study the effect of metal ions, synthetic medium, pH 6.5, of the following constitution was used: glucose (10.0 g), asparagine (2.0 g), KH_2PO_4 (1.0 g), $MgSO_4$, $7H_2O$ (0.5 g), water (1.0 litre).

The medium was treated with $CaCO_3$ to remove trace element contamination[3]. Asparagine was not included in the basal medium since amino acids form non-ionized complexes with micro-element impurities and can not be removed by $CaCO_3$ treatment. Instead, a suitable mixture of asparagine and yeast extract was prepared and this mixture was treated with dithiozone[4] in order to remove heavy metal contamination. The mixture was then passed through a ultra-fine fritted glass filter and added aseptically to culture flasks. The basal medium was distributed in 14.5 ml aliquots to the culture flasks. After adding the requisite amount of trace element solution, the medium was diluted with double distilled water to a final volume of 30 ml. A control flask was included with four trace elements and another without any. The compounds employed as trace elements were $Fe(NO_3)_3$; $9H_2O$, 0.2 mg/l, $ZnSO_4$; $7H_2O$, 0.2 mg/l ; $MnSO_4$, H_2O, 0.1 mg/l ; $CuSO_4$; $5H_2O$, 0.75 mg/l. Borosillicate glasswares were used throughout the experiment. These were rinsed with 6N nitric acid to remove surface-contaminants and washed several times with distilled water. The wash water was tested with dithiozone to confirm the elimination of metal ions. Flasks were incubated in stationary condition at 30°C. Growth was determined in terms of dry mycelial weights on every alternate days from 4th to 10th day of incubation. The filtered mycelia were washed thoroughly with cold water and kept in a hot air even at 90°C for 2 days, after which dry weights were taken. The relative toxic effect of different metal ions was calculated on the basis of metal ion necessary to inhibit growth of the organisms. The medium in double concentration was dispensed in culture tubes in 5 ml quantity. Different salt solutions were added to the tubes at desired graded concentration and the final volume was adjusted to 10 ml with distilled water. The salts tested were, $CuSO_4$, $5H_2O$; $Bi(NO_3)_3$, $5H_2O$; $3CdSO_4$, $8H_2O$; HgCl; $(CH_3COO)_2Pb$, $3H_2O$.

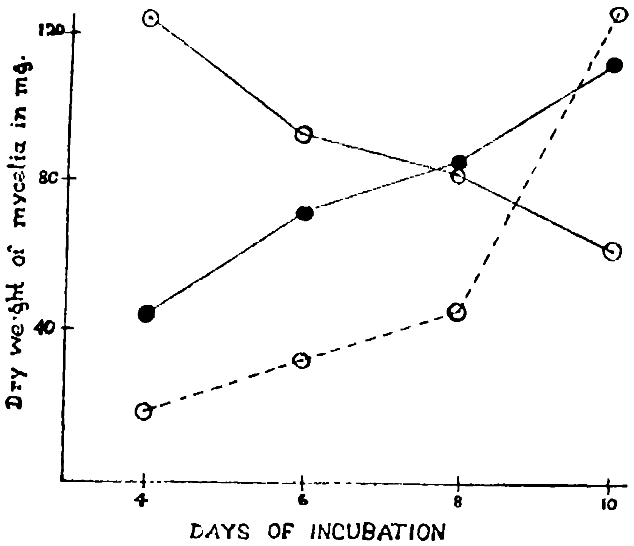

Fig. 1. Growth of the mycelia (in dry weight) at different days of incubation with all 4 micro-elements in the medium : ○—○ *R. capitata* ; ●—● *T. rubrum* ; ○---○ *M. gypseum.*

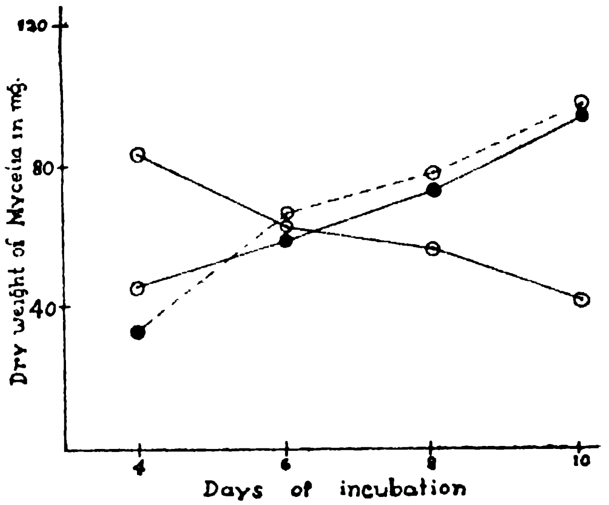

Fig. 2. Growth of the mycelia (in dry weight) at different days of incubation with micro-element, Zinc only, in the medium : ○—○ *R. capitata* ; ●—● *T. rubrum* ; ○---○ *M. gypseum.*

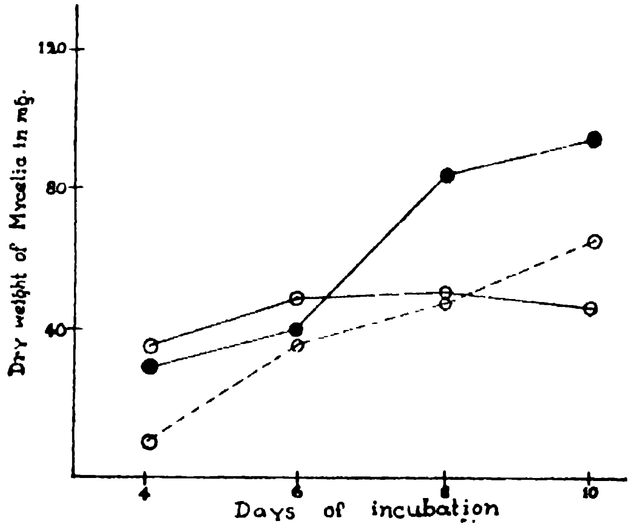

Fig 3. Growth of the mycelia (in dry weight) at different days of incubation with micro-element, Manganese only, in the medium : ○—○ *R. capitata* ; ●—● *T. rubrum* ; ○---○ *M. gypseum.*

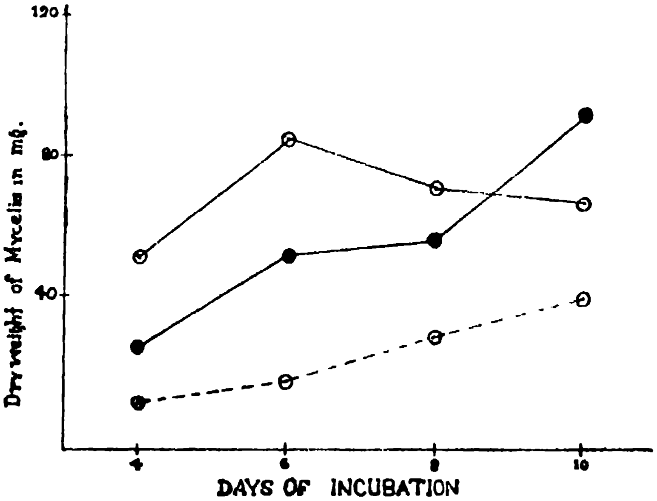

Fig. 4. Growth of the mycelia (in dry weight) at different days of incubation with micro-element, copper only in the medium : ○—○ *R. capitata* ; ●—● *T. rubrum* ; ○---○ *M. gypseum.*

When the fungi were grown in synthetic medium with all four trace elements, an abrupt increase in growth of the organisms was observed in general and of *R. capitata* in particular. However, *R. capitata* showed

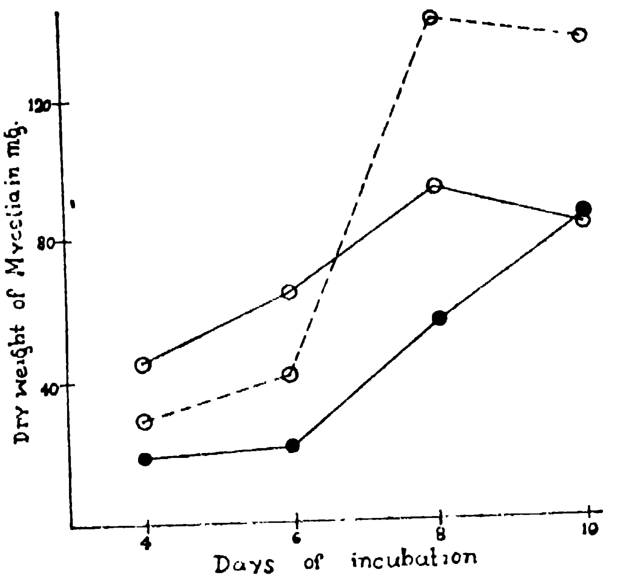

Fig 5. Growth of the mycelia (in dry weight) at different days of incubation with micro-element, Iron only, in the medium: ○—○ *R. capitata* ; ●—● *T. rubrum* ; ○---○ *M. gypseum.*

declining trend of growth after 4th day of incubation *T. rubrum* and *M. gypseum* exhibited exponential growth even up to 10th day. On the trace elements tested, zinc had instant stimulatory effect on *R. capitata* while copper and iron had only mild effect on it. Similarly, zinc, manganese, iron had stimulatory effect on the growth of *M. gypseum*, when added individually. However, growth of *T. rubrum* was mildly influenced by the micro-elements whether they were added together or individually (Figs. 1-5). When zinc was added to the medium singly or in combination with other micro-elements (Figs. 1 & 2) for the growth of *R. capitata*, the effect was instantaneous. The peak of the growth was achieved on 4th day of incubation. The growth declined gradually as nutrients depleted from the medium. None of the heavy metals tested excepting mercury had any toxic effect on *R. capitata*. The minimum inhibitory concentration (M.I.C.) of HgCl was 10 μg/ml. The MIC of Pb^{++}, Hg^{+} and Cu^{++} on the growth of *T. rubrum* were 2 μg/ml, 3 μg/ml and 3 μg/ml, respectively. None but Bi^{+++} was inhibitory to the strain of *Microsporum gypseum* and the M.I.C. was 5 μg/ml.

Morphological and cultural characteristics of *R. capitata*, *T. rubrum* and *M. gypseum* were found to change in the presence of heavy metals. In the control tubes, the growth was profuse, submerged with abundant number of chlamydospores. There was instances where surface growth was also found.

Zinc deficiency is known to cause distortion of carbohydrate and protein metabolism in fungi. The absence of any positive response of *T. rubrum* to zinc indicates that the particular strain does not require the micro-element. It is interesting to note that when all four micro-elements were added simultaneously the growth of the fungus was greatly enhanced. The stimulatory effect of iron and zinc was also observed in confirmation of the previous observation[5,6]. The inhibitory effect of zinc, mercury and silver on respiration of dermatophytes has been reported[7]. Earlier Chandra and Banerjee[8] established the toxic effect of lead, copper and cadmium on *Trichophyton*. The study on the effect of the metal ions on the three organisms shows that the organisms differed in their heavy metal ion sensitivity. *R. capitata* and *M. gypseum* could tolerate most of the toxic metals tested to a relatively high dose but growth of *T. rubrum* was inhibited by three of the six heavy metal ions used. Hg^{+} which affects growth by dissociating inner and outer membrances of mitochondria[9] has no effect on the strain of *M. gypseum*.

The results of our study suggest that a certain amount of nutritional parity exists among three organisms belonging to the Gymnoascaceae with regard to their microelement uptake but they differ distinctly in their reaction to heavy-metal ions.

The work was carried out under the supervision of Dr. A. K. Chandra, Deptt. of Botany, University of Calcutta, India and was supported by University Grants Commission, India.

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Received : *23 May, 1988.*
Revised : *17 March, 1989.*

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Abnormal wave motion in chromosomes with reference to cancer problem

The malfunctioning genes influence the vibrational spectrum and the wave motion in chromosomes[1,2]. The tendency of such genes is to form cluster. When functionally related genes are clustered together in the vertebrate genome, their functional activities are not coordinated[3]. The attraction between defect genes may be a general property of locally perturbed fields. Defects might be created by some means of excitation (radiation, chemicals, high temperatures, etc.). Induced mutations, whether of the localized type, i.e. the change or removal of one or more code units in a gene, or of the organizational type, i.e. transfers of portions of genetic material from one position to another, always have had an exquisitely random quality[4]. The randomness is, of course, the direct consequence of the chemical monotony of the genetic landscape.

When a supernormal gene of mass M is linked to its nearest neighbours by bonds with "force constants" S′, the frequency of the localized mode is given by[1]

$$f = (1 - \epsilon^2)^{-1/2}, \qquad (1)$$

where ϵ is the mass defect parameter $= 1 - Q$ ($Q = M/m$, m is the mass of the normal genes). In the unperturbed case, $S' = S$, the normal force constant.

As $M \rightarrow 0$, $\epsilon \rightarrow 1$, the abnormal frequency becomes infinite, corresponding to a loss of one degree of freedom[1]. In general, the localized modes associated with the abnormal genes are either symmetrical or anti-symmetrical about the position of the supernormal gene (genes to the left being either in or 180° out of phase with those to the right). As the mass of the defect gene is reduced, the frequency of the symmetric mode increases and its range of influence on its neighbours decreases. As $M \rightarrow 0$ (missing gene, discussed later on), the effect of the mode is no longer propagated through the chromosome. The only mode associated with a missing gene on the chromosome is the anti-symmetric one ; this mode exists independently of the mass of the abnormality provided the new force constant is sufficiently large.

If the force constant associated with the interaction between the abnormal gene and its neighbours be S'', the frequency equation for the perturbed system can be obtained from De[1] provided ϵ is replaced by ϵ' where $\epsilon' = 1-P$, P is the relative force constant ($\equiv S/S''$) and ϵ' the force defect parameter which is given by

$$\epsilon' \tan \theta/_2 = \tan \frac{N\theta}{2}, \qquad (2)$$

N is the number of genes on the chromosome, $\sin^2 \theta/2 = \omega^2/\omega^2_M$, m is the mass of the normal genes and ω_M is their highest frequency. In a particular case when $S'' \gg S$, one can obtain the abnormal mode with a frequency given by

$$f = (1 - \epsilon'^2)^{-1/2}, \quad \epsilon' \leqslant 1 \qquad (3)$$

This frequency is associated with an anti-symmetric vibrational mode, i.e. one in which corresponding genes on opposite sides of an anomalous force constant vibrate 180° out of phase. Missing gene or genes from the linear chain may be caused by X-rays or ultraviolet radiation, etc. (Carcinomas can be induced by agents of a highly diversified nature, such as u.v. radiation, chemicals and oncogenic viruses). Radiation is thought to cause cancer through mutation[5]. It is known, from the work on viruses, that within a gene a few sites are exceptionally mutable, often 100 times more than the other sites—the so-called "hot spots" of spontaneous or induced mutation[4]. Whatever the nature of these spots may be, they indicate that exceptional vulnerability of some portions of genes by otherwise nonspecific mutagens is within the realm of possibility.

A missing gene can be characterized by $P = Q = 0$, since the original gene mass is removed and therefore no potential energy of interaction exists with its neighbours. An interesting case arises when $P > 1$ and $Q = 0$. The repulsive force which keeps its neighbours in their places is removed so that a tendency exists for them to come into the vacant place. This tendency is characterized by coupling the neighbours of the gap by a stronger than normal force constant ($S' > S$) or in which the neighbours on opposite sides of the missing gene are coupled together with a force constant S'' $\frac{1}{2}S' > \frac{1}{2}S$. This will lead to a perturbed frequency equation given by (2) provided ϵ' is replaced by ϵ'' where $\epsilon'' = 1 - P'$, $P' = 2S/S'$, $S' > S$. In a particular case of the abnormal frequency, this will again lead to

$$f = (1 - \epsilon''^2)^{-1/2}, \quad S' > S \qquad (4)$$

(Without changing the topology of the gene system, the abnormal force constant may be assumed to span the vacant place of the missing gene so that it is extended over two gene spacings rather than the usual one per DNA strand). The choice of $P = \frac{1}{2}P'$ can be used to correspond to a consistent model of the missing gene. In the case of two missing genes, Q is to be replaced by $2P^{-1}$).

The missing gene may not change the structure of the mode but eventually causes a readjustment of the amplitude of vibrations of the neighbouring genes. This readjustment is propagaged through the chromosome with a finite velocity and influences the chromosomal motion.

Another type of variation of gene system leading to chromosomal abnormality is the interstitial, a normal or defect gene of new character inserted between normal genes causing a static distortion of the chromosome. Since an interstitial has the same topology as a defect-gene mass at a normal chromosomal position the analysis can be made from the equations derived above. It is seen that the qualitative effect of increasing (decreasing) a particular force constant is very similar to that of decreasing (increasing) a single mass, i.e. a strong defect (Q high) implies "softtened" force constant.

The theory of scattering of plane waves can be applied to the problem of scattering by a defect gene. When a travelling wave in a chromosome (from left to right) impinges on a supernormal gene, it will, in general, be scattered. The scattered wave must contain both a reflected and a transmitted part across the defect gene The transmission and reflection coefficients are given by

$$T = \frac{1-f^2}{1-f^2(1-\epsilon^2)}$$

$$R = \frac{\epsilon^2 f^2}{1-f^2(1-\epsilon^2)} \qquad (5)$$

When $\epsilon \rightarrow 0$ (unperturbed case), the waves are fully transmitted across the genes. When $\epsilon \rightarrow 1$, one gets $T=1-f^2$ and $R=f^2$; in this case, the transmitted part will be greater than the reflected part. Again, when $\epsilon < 0$, the reflection coefficient plays a significant part. Thus, the malfunctioning genes on the chromosome have some direct influence 'on the reflection and transmission coefficients. The wave of replication if starts from one end of the single gene string or from a particular site on the chromosome is affected due to the presence of such abnormal genes. (The number of replication points per chromosome, however, depends on the growth medium and culture conditions[6]).

For a defect cluster where there are two adjacent genes (each of mass M), one will find that the effect of such defect cluster is similar to that found for the case of a single abnormal gene[1]. If the abnormal genes are heavy, the frequencies are displaced towards lower values by amounts of order O(1/N), N is the total number of genes. If the abnormal genes are lighter than the other genes on the chromosome (due to specific changes in the structure of specific genes), the frequencies are shifted to slightly higher values of order O(1/N). In addition, there appear one or two frequencies (localized disturbances) outside the range of the spectrum of normal frequencies which, of course, depend on the relative mass. In case of mutations due to the alteration of double genes, the frequency of a single defective or incomplete gene system (equation 1) is split into two frequencies (localized modes) given by

$$f^2 = 1/[4\epsilon(1-\epsilon)]$$

$$= 2[(8\epsilon + 1)^{1/2} + 1 - 4\epsilon]^{-1} \qquad (6)$$

Two localized modes will occur if $Q < 0.5$, if $0.5 < Q < 1$ then only one such mode exists. For a more complicated cluster-defect systems (mutations due to the alteration of any number of genes), if one has a cluster of r genes ($Q < 1$) in the linear chain (coupled to one another by DNA strands which are supposed to act as springs), r localized modes will occur (when $Q << 1$). A "strong" defect ($Q \rightarrow 0$, $\epsilon \rightarrow 1$, i.e. a very low mass defect introduced into the chromosome) exerts its influence through the localized modes. If

$\epsilon \rightarrow 0$, the frequencies of the localized modes will, one by one, coalesce with the continuum. The final out-of-frequency band enters the continuous spectrum at $Q=1$, which has been discussed[2].

If the defective genes are very far apart, they will lead to a localized normal mode of the same frequency. As the defective genes are closer together, the degeneracy splits. If the coupling of the abnormal gene is very weak, the motion of a given gene located between the two abnormal genes can be approximated as a linear combination of the two isolated defect modes. In such a case, the motions of the gene of interest due to each defect mode are either in phase or out of phase. The in-phase motion corresponds to an enhancement of the amplitude of chromosomal motion, whereas in the out-of-phase motion interference is expected to occur. The out-of phase mode has one less mode than the inphase one and is associated with the low-frequency number of the split pair.

To consider an experimental test of theoretical results discussed here, it is obviously necessary to examine some property which picks out the motion of the malfunctioning genes alone and which measures its frequency response. Gene regulation is essential to restore normal frequency spectrum.

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Received: 20 September, 1988.

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Chemical detection of several liquid organic compounds with two newly developed decolourised basic fuchsin solution

Sulphuric acid along with sodium sulphide, are good combinations to reduce various cationic dyes, such as toluidine blue O, brilliant cresyl blue and Meldola's blue to a colourless or pale straw colour[1]. With this combination, Giemsa, which is a tetrachrome blood stain and pinakryptol green, a cationic dye, can also be reduced to a red colour and pale red colour respectively when seen in a test tube[2]. Such is also the case when azure A, methylene green and crystal violet are charged with 1/N H_2SO_4 and $Na_2S.2H_2O$[3]. The present experiment was undertaken with a view to finding out if sulphuric acid and sodium sulphide would also reduce basic fuchsin, a dye of the aminotriarylmethane group, to a colourless or semi-colourless state and yet would be useful to detect the presence of liquid organic compounds. The method of preparation of the dye-reagents are as follows:

Dye reagent A: To a 0.2% aqueous solution of basic fuchsin (E. Merck) prepared with 100 ml of warm distilled water are added 5 ml of 1/N H_2SO_4 and 1.0 g of sodium sulphide. These are mixed well and then filtered. The filtrate is pale-straw coloured and, on keeping in the refrigerator for 1-2 hr, becomes completely colourless. The pH of this reagent is 8.5.

TABLE 1 : **Colour reactions of organic compounds with the two dye-reagents**

Compounds	Dye-reagent A	Dye-reagent B
I. *Alcohols*		
(a) Methyl alcohol	+ve	+ve blue)
(b) Ethyl alcohol	+ve	+ve (violet)
(c) n-Propanol	+ve	+ve (pale blue)
(d) iso-Propanol	+ve	+ve (pale blue)
(e) n-Butanol	+ve	+ve (,,)
(f) Iso-Butanol	+ve	+ve (blue)
(g) tert-Butanol	+ve	+ve (violet)
(h) n-Pentanol	+ve	+ve (pale blue)
II. *Ketones*		
(a) Acetone	+ve	+ve (blue)
(b) Methyl ethyl ketone	+ve	+ve (blue)
III. *Aldehydes*		
(a) Formaldehyde	+ve	+ve (magenta)
(b) Acetaldehyde	+ve	—ve
(c) Glutaraldehyde	+ve	+ve (magenta)
(d) Paraldehyde	+ve	+ve (,,)
(e) Benzaldehyde	+ve	+ve (blue)
IV. *Carboxylic acids*		
(a) Formic acid	+ve	—ve
(b) Acetic acid	—ve	—ve
(c) Linoleic acid	+ve	—ve
(d) Oleic acid	+ve	—ve
V. *Ethers*		
(a) Dioxane	+ve	+ve (pale blue)
(b) Solvent ether	+ve (lower blue ; upper colourless)	—ve
VI. *Amines*		
(a) Tributylamine	—ve	+ve (magenta)
(b) Dimethylaniline	—ve	+ve (,,)
(c) Pyridine	+ve	+ve (,,)

Dye-reagent B: To 100 ml of warm distilled water is added 2 mg of basic fuchsin and it is dissolved thoroughly by shaking. To this dye solution is added 50 ml of conc HCl and mixed well. This does not require filtration as it looks transparent yellow in colour. The pH of this dye-reagent is 2.7.

The organic compounds tested to yield positive or negative results with each of the dye-reagents are presented in Table 1.

Dye-reagent A, prepared with $1N/H_2SO_4.2H_2O$, however, resembles Schiff reagent in so far as the method of preparation is concerned. The differences are that Schiff reagent turns purple, on being heated over a flame or when irradiated under shortwave UV rays[4], whereas the present one does not do so. Furthermore, the different Schiff reagents prepared by different methods have acid pH, whereas the present is highly alkaline. Not only this, Schiff reagent stains DNA-aldehyde molecules in acid-hydrolysed tissue sections in the regular Feulgen reaction, whereas the present one does not. Under the circumstances, the author feels that the present dye-reagent should not be confused with Schiff reagent. This reagent (A) when allowed to react with chemical compounds produces magenta colour only. Regarding the ability of this reagent to detect different classes of compounds, it can be said that for the detection of alcohols, a 7-day old reagent is suitable.

The method of preparation of dye-reagent B is very simple and it takes hardly a minute to prepare. In this regard, it has advantage over dye-reagent A. Not only this, the shelf-life of this dye-reagent is easily 10 days. It is interesting to mention here that this dye-reagent detects most of the alcohols, ketones producing blue or violet colour and aldehydes and amines to yield magenta colour. Carboxylic acids cannot be detected with this reagent.

It is necessary to mention here that basic fuchsin dye-reagent prepared with perchloric acid and sulphuric acid[5] reacts with the different organic compounds and produces colourations which are totally different from those obtained with the present dye-reagent, as mentioned in this communication. This phenomenon reflects the fact that the molecular configuration of the dye changes differently when the same dye-solution is reduced to a semi colourless state with the different substances. Although no attempt was made to test the solid organic compounds with dye-reagent B, it may be possible that colour formation may result if these are dissolved in solvent ether, since this compound does not yield colour formation.

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Received: *29 September, 1988.*

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A possible role for aminotransferases in proline accumulation in groundnut cotyledons during saline stress

Proline accumulation in plants subjected to abiotic stress is a common phenomenon[1]. The accumulation of proline in various plant tissues during saline stress has been documented by several workers[2-6]. The metabolic causes for proline accumulation have not been well understood. Increase in the levels of proline during saline stress has been attributed to increased proteolysis[5]. Increased synthesis from glutamate has been suggested as another source[6]. Glutamate is the precursor for biosynthesis of proline[7]. The present work has been undertaken to study the changes in the levels of the aminotransferases involving glutamate.

Groundnut seeds (*Arachis hypogea* L. cv. G_2) obtained from Tamil Nadu Agricultural University, Coimbatore, were surface-sterilised with 1% $HgCl_2$ solution and after thorough washing with distilled water were divided into 2 batches of 50 seeds each. One batch of seeds was soaked in 0.1 M NaCl solution for 3 hours. The second batch of seeds, forming the control group was soaked in distilled water for a similar period. After 3 hr, the seeds were removed and allowed to germinate on 2 layers of filter paper in Petri-dishes at 30 ± 2°C in 0.1 M NaCl and distilled water separably in the presence of light. Estimations of the amounts of amino acids and the activities of the enzymes were carried out at the end of 72 hr. Proline from cotyledons was extracted with 3% sulfosalicylic acid solution and estimated by the method of Bates *et al*[8]. Amino acids and proteins were extracted according to Mahadevan and Sridhar[9]. Amino-acid content of the extracts was determined by the ninhydrin method[10] and the glutamic acid in the extracts by paper chromatography[11]. Protease from cotyledons was extracted with 0.1 M phosphate buffer pH 6.6 under ice-cold conditions and the activity determined according to Mathur *et al*[12]. Aspartate aminotransferase (E.C. 2.6.1.1) and alanine aminotransferase (E.C. 2.6.1.2) were extracted from cotyledons with 0.1 M phosphate buffer pH 7.4 under ice-cold conditions and the activities estimated by the

TABLE 1 : **Effect of saline stress on the amino acid and protein content of cotyledons in germinating *Arachis hypogea* after 72 hr**

Parameter	Group	
	Control	Saline
Amino acid (mg/g fresh wt)	15.01 ± 0.45	24.42 ± 0.76
Soluble Protein (mg/g fresh wt)	32.60 ± 1.31	46.07 ± 0.94
Proline (μ moles/g fresh wt)	2.14 ± 0.06	2.88 ± 0.08
Glutamic acid (μ moles/g fresh wt)	11.23 ± 0.32	16.07 ± 0.34

Values are mean of 6 separate estimations ± SE.

TABLE 2 : Effect of saline stress on protease and aminotransferase activities in cotyledons of germinating *Arachis hypogea* after 72 hr

Enzyme	Group	
	Control	Saline
Protease (μg tyr released/hr/mg protein)	9.24 ± 0.36	6.68 ± 0.31
Aspartate aminotansferase ($\times 10^{-3}$ μ moles keto acid formed/min/mg protein)	143.6 ± 5.4	101.8 ± 2.9
Alamine aminotransferase ($\times 10^{-3}$ μ moles keto acid formed/min/mg protein)	42.2 ± 0.9	27.8 ± 0.8

Values are mean of 6 separate estimations ± SE.

colorimetric method using 2, 4-dinitrophenylhydrazine[13]. Protein in extracts was estimated by the method of Lowry *et al*[14].

Tables 1 and 2 show that in germinating groundnut cotyledons, at the end of 72 hr, proline, glutamic acid, total amino acids and soluble proteins increased during saline stress. The activities of protease, aspartate aminotransferase and alanine aminotransferase in the cotyledons of the NaCl treated seeds were lower than that of the control values (Table 2). The decline in the activities of the two aminotransferases is accompanied by an increase in glutamic acid content in cotyledons in saline stress. Thus, it is likely that the conversion of glutamic acid to α-ketoglutarate is reduced. Part of the accumulating glutamic acid may be diverted towards proline biosynthesis. This will be in agreement with the results obtained earlier[6]. Although glutamate may act as the major source for proline accumulation during saline stess, two additional routes, to a lesser extent, may also contribute. Garg and Garg[15] had observed decreased protein biosynthesis during saline stess. According to Sudhakar *et al.*[5], proline dehydrogenase activity is reduced in salinity. Thus, a decreased utilization of proline towards protein biosynthesis and decreased degradation by proline dehydrogenase may also contribute towards increase in proline levels. The decrease in protease activity observed now is contrary to the results obtained earlier[5]. Thus, protease action may not contribute significantly in increasing proline levels. The increase in the total amino acid content may partly be due to higher levels of proline and glutamic acid and partly due to decreased utilization for protein biosynthesis observed in saline stress. It has been reported that saline stress depresses the levels of gibberellic acid in cotyledons[16]. Gibberellic acid is known to induce hydrolases during the germination of seeds[17]. Thus, the decrease in protease activity observed now could be due to depressed levels of gibberellic acid.

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Received : 7 November, 1988

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Chemical deblossoming of peach (*Prunus persica* Batsch) as an aid to quality improvement

Fruit thinning is a standard practice in temperate areas for production of quality peaches[1]. To replace the laborious practice of hand thinning with chemical deblossoming agent, studies were carried out on Shan-i-Punjab (16-33) peach by spraying Planofix (sodium salt of 1-naphthyl acetic acid-NAA) at full bloom stage.

The investigations were undertaken in the Department of Horticulture, Punjab Agricultural University, Ludhiana, during 1986. Planofix was sprayed at 0, 25, 50, 75, 100 and 200 ppm concentrations on nine years old trees during February. Experiment was laid out according to the Randomized Block Design on ten uniform peach trees. In all there were six treatments with three replications in each. During mid May, observations were recorded on physico-chemical characteristics of fruits.

It is evident that fruits retained at harvest declined considerably with the increasing concentrations of Planofix as compared with the trees sprayed with water (Table 1). With 25 ppm spraying, 43.13% fruit retention was obtained and this was significantly greater than all the other treatments except with 50 ppm concentration which showed a retention of 38.22%. From the earlier studies on cv. Flordasun peach, 25 ppm application of 'Planofix' at full bloom caused 63.13% fruit retention[2]. Planofix at 75 ppm concentration and above showed over thinning of fruits. Phytotoxicity was also observed with 200 ppm spraying. In earlier reports, α-NAA spray at 200 ppm completely defoliated Regina and Early Red Haven peaches[3,4]. When Cardinal and Red Haven peaches were sprayed at full

TABLE 1 : **Effect of Planofix on the physico-chemical characteristics of peach cv. Shan-i-Punjab**

Treatment of Planofix (ppm)	Fruit retention	Fruit weight (gm)	Pulp/stone ratio	T.S.S. (%)	Total sugars (%)	Acid content (%)	Vit. C (mg/100 gm)	Pectin (Ca Pectate) (%)
Control 0	58.67	85.94	14.97	9.10	6.91	0.71	3.60	0.15
25	43.13	107.50	15.10	10.76	7.25	0.63	4.00	0.19
50	38.22	113.04	16.90	12.50	8.05	0.65	5.81	0.17
75	26.46	115.44	16.32	11.65	7.54	0.70	4.04	0.16
100	18.80	99.70	15.61	11.62	7.28	0.68	5.12	0.17
200	14.52	103.94	15.90	10.40	7.43	0.72	4.52	0.17
C.D. at 5% level	13.42	8.16	—	1.14	—	—	8.85	—

bloom stage, the 60 ppm concentration of NAA caused over thinning of fruits[5]. The effective thinning with 400 ppm Na-NPA, 5 days after full bloom or 500 ppm NAA during flowering was also noticed. However, Na-NPA caused considerable tree damage. This variation in dose response may be mainly due to the varietal and tree age differences and the blooming stage at which chemicals were sprayed. Secondly, the prevailing climatic conditions of the locality also determine the dose response of growth regulators.

Planofix at 75 ppm concentration produced highest fruit weight (115.44 g) and this was followed by 113.04 and 107.50 g weights with 50 and 25 ppm sprays respectively. However, these treatments did not differ significantly. Control trees with largest fruit retention (58.67%) produced very low weight (85.94 g) per fruit. From this data, it is clear that greater the fruit number, smaller is the fruit size. Pulp/stone ratio of the peach fruits did not differ significantly between the chemical sprayed and control trees.

Planofix application did not improve significantly the quality parameters of Shan-i-Punjab (16-33) except total soluble solids (T. S. S.) and vitamin C content. Planofix at 50 ppm spray produced higher T. S. S. value of 12.50 per cent and this was followed by 11.65 and 11.65% T.S.S. obtained with 75 and 100 ppm respectively. These treatments were at par with each other in improving the T.S.S. of the fruits. However, these were significantly superior to the unsprayed control trees. Higher values for vitamin C (5.81 and 5.12 mg/100 g) were obtained with 50 and 100 ppm concentrations and these were significantly better than the vitamin C content produced by all other treatments.

The effect of Planofix sprays on total sugars, acids and pectin content was not significant and consistent. On the basis of foregoing results, the application of 50 ppm 'Planofix' is beneficial as per as the fruit retention, size, T.S.S., and vitamin C content of Shan-i-Punjab peach fruits are concerned.

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Received : 3 November, 1988.
Revised : 26 June, 1989.

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Symptoms of nematode attack on hybrid napier

Hybrid napier, a hybrid of napier grass (*Pennisetum purpureum*) and Bajra (*P. typhoides*), popularly known as Elephant grass, is a promising perennial fodder crop, commonly grown in Assam, West Bengal, Bihar, Orissa, Utter Pradesh and Punjab. No pest and diseases were reported to cause damage to this crop except some occasional incidences of shootborer[1]. A preliminary faunistic survey of plant-parasitic nematodes of forage crops has already been published[2]. Some nematodes are pathogenic to these crops[3,4].

Lesion nematodes, *Pratylenchus* (2 nematodes per cc soil), lence nematodes, *Hoplolaimus* (8 nematodes per cc soil), spiral nematodes, *Helicotylenchus* (5 nematodes per cc soil) and stunt nematodes, *Tylenchorhynchus* (6 nematodes per cc soil) are found to be associated with the hybrid napier of Jhansi showing symptoms of chlorosis and reduced root system.

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Received : 13 February, 1989.
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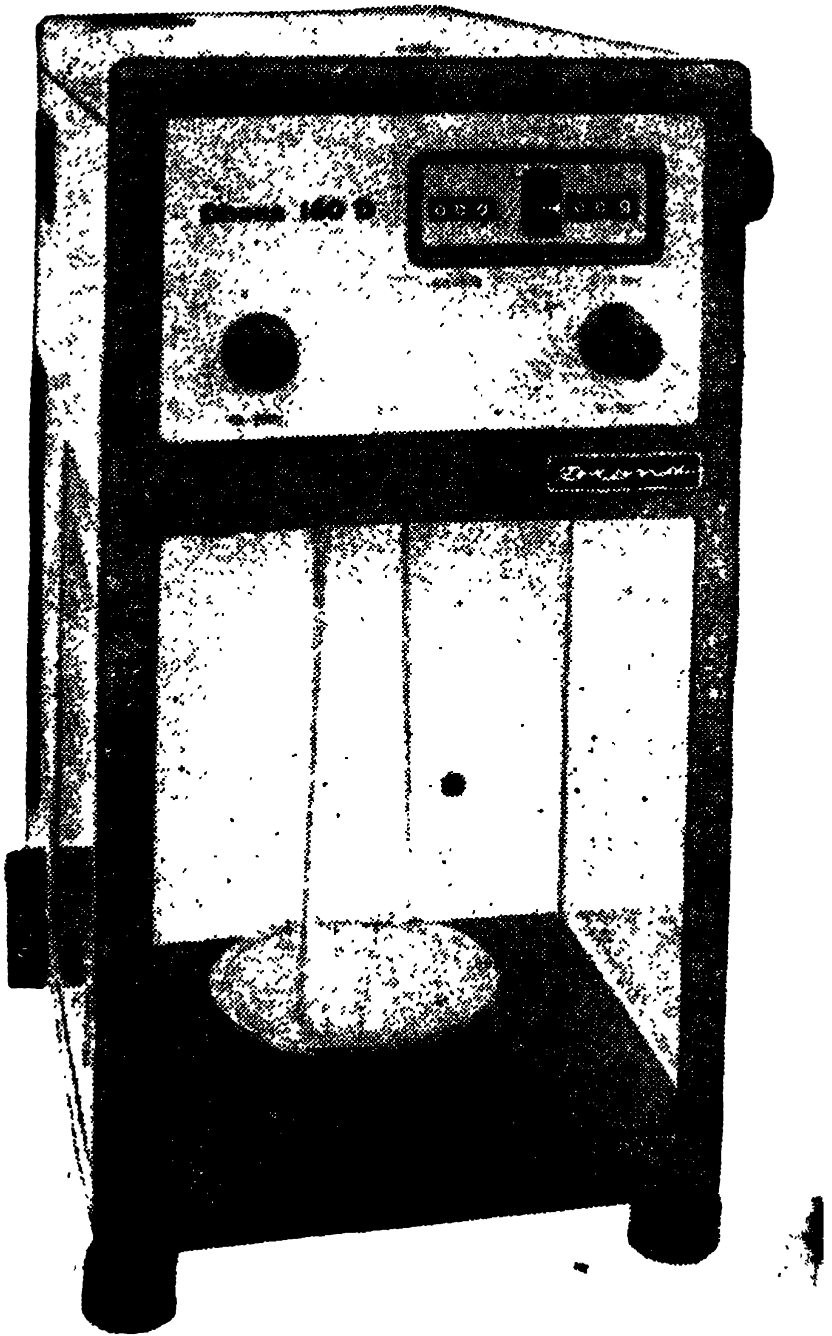

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Published and Printed by Santimay Chatterjee, on behalf of the Indian Science News Association,
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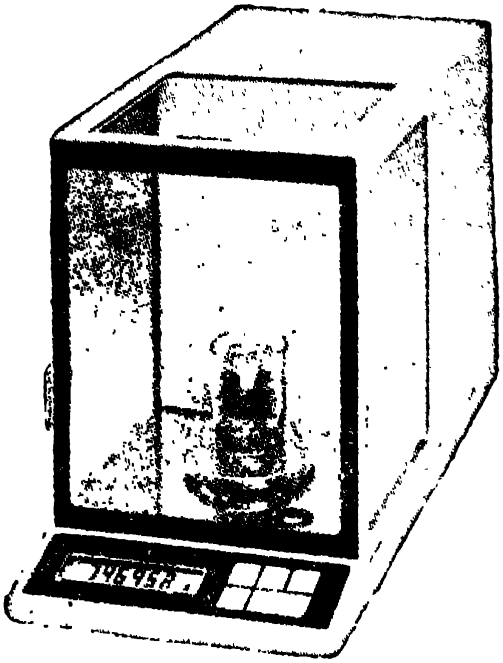

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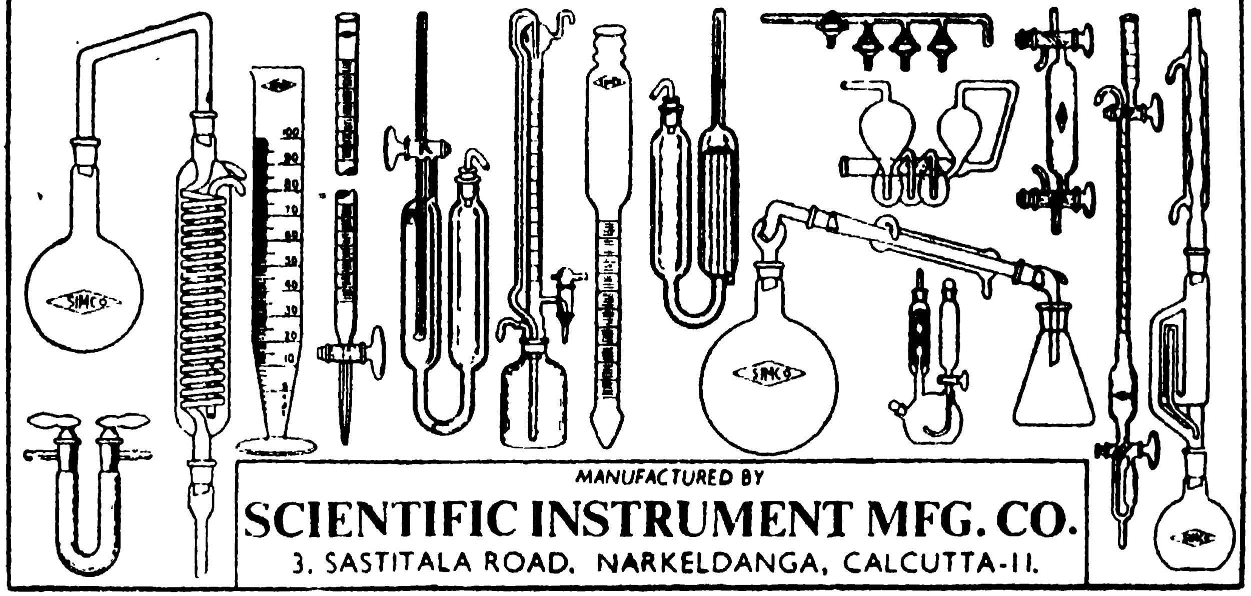

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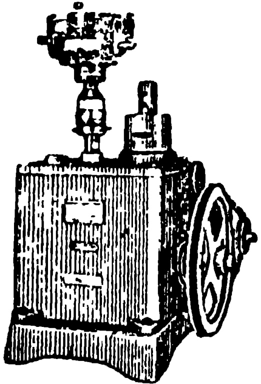

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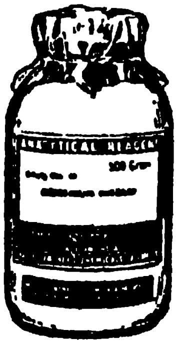

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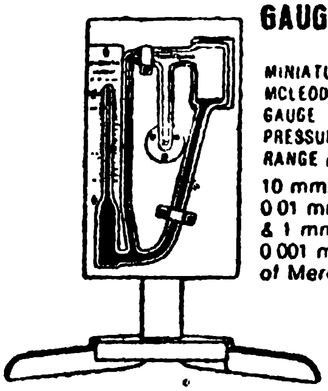

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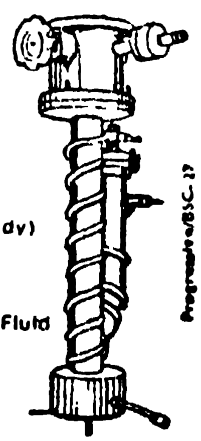

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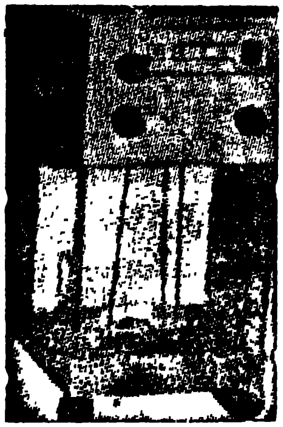

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CHEMISTRY IN RURAL DEVELOPMENT

A large majority of Indians live in villages and hence betterment of their lot would primarily determine the overall progress of our nation.

Rural economy is mainly dependent on agriculture and chemistry has much to contribute in this field. The use of synthetic fertilizers is a classical example, but the role of mineral micronutrients of later recognition has a great promise for future. Deficiencies of such micronutrients have adverse effects on the yield of a farm land and quality of the product which ultimately also produces adverse effects on human health. A significant example being zinc deficiency in most of the UK farm lands which is ultimately responsible for large scale zinc deficiency psychological diseases in the country.

Production of new disinfectants, pesticides and insecticides, etc. which would be more economical but at the same time potent for the purpose, but more readily degradable in nature and are less harmful to higher form of life than the presently used ones, is another area where chemistry can make a significant contribution.

Another area of concern is conversion of organic waste materials including human and animal excreta, by chemical/biochemical methods into clean gaseous fuels. Bio-gas plants are one such example which provide clean gaseous fuel alongwith a residue which is a good manure. Domestic garbage and water-hyacinth, which grow profusely in ponds and marshy lands, are good feed stocks for bio-gas plants. In this way waste and unwanted materials are converted to useful products and at the same time help controlling environmental pollution. One can also think of economical low temperature thermal and particularly photochemical methods of generating hydrogen from water for use as a fuel, using solar energy normally available in plenty in villages in tropical countries. Chemical reactions initiated by sunlight which are reversed in the dark releasing the trapped energy is another promising area of research for economic utilisation of solar energy. Chemical systems also have great promise for storage of solar heat. In many chemicals phase transformations and structural changes take place with absorption of heat which are reversed when the heating is cut-off liberating the absorbed heat. This is much more efficient than physical storage of heat as specific heat of a material. Fermentation technology may also be improved for producing fuels like alcohol from vegetable products, particularly high yielding plants which may be harvested more than once a year. This is an indirect method of trapping solar energy by biochemical method.

Population control is another area where chemistry can make a major contribution. Birth control pills, both for female and male, which need to be used at long intervals, say once a month, and chemical methods of abortion using suitable drugs appear to be of great promise in future. Ideally, one need think of such chemicals which can be administered through staple food articles that are unavoidably used by every individual, such as salt, sugar, flour, oil, etc. Such an approach appears ideal for the village folk of a developing nation who hardly realise the need for family planning.

Much fundamental research is needed in the above mentioned areas to achieve the goal. □

D. Banerjea

INTEGRATED PEST MANAGEMENT : PROGRESS & PERSPECTIVE IN INDIA

R. C. JOSHI* AND N. C. JOSHI**

For achieving success in pest management, a precise understanding of the latest crop-protection technology consisting of surveillance and forecasting of pest outbreaks, use of resistant varieties, adoption of good cultural practices, use of biological control methods, anti-feedents, pheromones, irradiation techniques, microbial agents and need-based application of pesticides, when pests were above economic threshold, as a last resort, have to be adopted. This integrated approach will reduce the pest population to such an extent that it cannot deprive the farmer to obtain economic returns. The progress and perspective of this concept of pest management (IPM) have been described in the present paper.

In India, about 18% of crop yields is lost due to ravages of pests (i.e. weeds, diseases, insects, rodents and storage losses at 33%, 26% 20%, 6% and 6% respectively). In terms of money, the crop lost due to these pests is about 6000 crores every year[1]. The magnitude of damage due to pests in India are well-known and has been amply documented.

There is now more awareness and enthusiasm amongst the farmers for taking up plant-protection measures as it was 15 years ago.

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It is evident from increasing coverage under plant protection was 40 million hectors (ha) in 1968-69 and 112 million ha in 1986-87. In view of this, it is very necessary to adopt plant-protection measures at the proper stage.

With the introduction of new high-yielding varieties and hybrids growing in irrigated areas under high-fertility condition, the pest problems have increased. For instance, in TN-1 and IR-8 the bacterial leaf blight (BLB) and *Tungro virus* have appeared in severe form. Similarly, Ergot and Downy mildew in hybrid bajra are posing problems. Some new problems pertaining to weeds, i.e. wilt oat (*Avena fatua*) and Canary grass (*Phalaris minor)* in wheat-growing areas and carrot grass (*Parthenium hysterophorous*) in non-crops areas are problems of all-India importance.

Although research on crop pest and disease has been carried out in India since the beginning of the present century, organised plant-protection measures did not start till 1939 during which the Locust Warning Organisation w s established as a result of the locust plague[3] during 1926-32.

Later on, the Government of India established in 1946 the Directorate of Plant Protection, Quarantine and Storage with the objective of assisting in the protection of crops and crop produce from pests and disease attack following the recommendation of Woodhed Famine Commission (1945) to enquire into the Bengal Famine of 1943.

The Directorate also established Plant Quarantine and Fumigation Stations at major airports, seaports and land frontiers and 14 Central Plant Protection stations in 1957 in different parts of the country. The objective of the Locust division of the Directorate has been to do regular survey, surveillance and monitoring of locust breeding, build-up, movement and control in scheduled desert area of Rajasthan. These stations were established to conduct similar pest and disease survey, surveillance and monitoring on major agricultural crops in different parts of the country and to advise/adopt plant protection measures with the help/collaboration of State Departments of Agriculture. During 1972-73, a pest and disease surveillance scheme with 12 Central Surveillance stations in different parts of the country was launched with the main aims of studying the pest and disease situations in more detail by fixed plot as well as roving surveys on major agricultural crops.

Consequent upon, the widespread epidemic of Green-leaf hopper and *Tungro virus* during kharif 1968-69 in West Bengal, Bihar and Uttar Pradesh, the Directorate initiated rapid-roving surveys in collaboration with the Ford Foundation, Indian Council of Agricultural Research (ICAR) and the States of Uttar Pradesh, Bihar, West Bengal, Orissa and Madhya Pradesh in 1970 and this conti ued up to 1973. These surveys are being continued on *ad hoc* basis by the Directorate of Plant Protection, Quarantine and Storage in collaboration with the State Departments of Agriculture and the ICAR, in the above States till date and have been extended to Assam, Punjab, Haryana, Rajasthan, Gujarat, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu both in Kharif and Rabi seasons on paddy, oilseeds and pulses.

With the advent of high-yielding varieties and adoption of intensive agricultural development/production technology, pest and disease problems have aggravated manifold and the technology used to control the pest is mostly by the use of intensive and extensive chemical pesticides, pesticides which resulted into pest resistance to pesticide, pesticide residues, health hazards, environmental pollution and ecological imbalance. To obviate the above difficulties in the technology in use, it was desirable to have a rethinking on the methods and techniques for pest control by pest management rather than pest control based on fixed schedules, etc. This thinking resulted into the use of Integrated Pest Management which means judicious use of compatible combination of cultural, mechanical, biological and chemical control measures.

Management of pest with different components of IPM

(i) *Use of chemicals* : Prior to late 19th century, ploughing, planting and water schedules were the main methods used to control pests. At the turn of the century and up to the 1940s, organic plant derivatives and minerals such as sulphur, arsenic containing components were used for pest control. From 1950, the pest-control measures were largely based on synthetic pesticides. Now considerable progress has taken place on chemical control in our country. The study revealed that the cost-benefit ratio was high in case of seed treatment ranging from 10 to 45 because of low cost of seed treatment, where as post sowing treatment ratio ranged from 2.3 to 9.5. Our country is producing about 46,600 tonnes of 46 different pesticides indigenously manufactured and about 12,400 tonnes imported. The average use of pesticide in our country is about 420 gm against 10,000 gm in Japan. For keeping quality of pesticides, ISI published 45 standards for technical grade and 55 formulated products. All these standards have been accepted under Insecticides Act, 1968, which aims at regulating the production, transport, storage, sale and use of pesticides. While pesticides are still the dominating tools used against pest, it is conceded that they do not form the means to end pests. The total eradication of pest is almost impossible in modern agricultural technology. Moreover, the indiscriminate use of pesticides resulted in problems like residue, developing resistance in insects, air/water/soil pollution and depletion of natural enemies of injurious species.

In view of the above mentioned hazards, the present strategy is, therefore, towards integrated pest management (IPM). The IPM system makes use of all the available methods of prevention and control. This approach has low-energy input and ensures minimal ecological disturbance, no environmental pollution and utilization of the available manpower with the aim to obtain optimal results over the long term. This system requires all the available components including preventive and regulatory measures.

(ii) *Climate versus post-surveillance* : Insect pests particularly depend on the climate, directly with regard to their reproductive potential, which determines population levels and the number of annual generations, and also with regard to the occurrence of important physiological processes, such as diapause. Climate also regulates the occurrence of the phenological coincidence between the development of the host plant, the pest and associated natural enemies.

Climate parameters such as the photoperiod, over-all radiation, relative humidity, etc., are involved in the development process and, hence, in the establishment of life tables of the pest for effective pest management.

Pest-surveillance information concerning the presence of pests or absence of pests, so that pesticides will be applied only when it is needed. This would eventually result in reduction of cost as plant-protection measures using pesticides are expensive. Pest-surveillance activities are, therefore, of vital importance in IPM.

(iii) *Cultural methods* : The judicious use of fertilizer, adjustment of planting time, timely irrigation, deep ploughing, weed control burning of crop residues, early harvesting, clean sanitation, crop rotation, plant spacing, trap cropping, choice of area, helps in minimising pest problems. In many locations, short-duration varieties have proved useful since they mature before pests become serious. In order to reduce the intensity of insect pollution, the use of light traps may also play a good role in minimising pest population.

(iv) *Use of resistant varieties* : The use of resistant and tolerant biological varieties of crops aim at pest/disease avoidance rather than their control. In the USA, it has been found that by adopting this method the cost-benefit ratio has increased 1 : 300.

(v) *Biological control* : The fact is that natural mortality is the most and cheapest element in avoiding pest outbreaks ; hence, the use of parasites and predators is another method which needs to be explored. There are about 110 pests in more than 60 countries that have been managed by the use of parasites, and predators. Complexes of biological control agents have been identified for almost all major insect pests of crops. Many of these predators, parasites and pathogens work effectively to regulate insect-pest populations. Since insecticides have detrimental effects on predators, parasites research is beginning to determine the interaction of vital resistance with biocontrol.

(vi) *Other methods and techniques* : Use of microbial agents—The promising technique is the use of pathogenic miro-organisms such as bacteria, virus, protozoa, fungi, etc. against pests. The organism *Bacillus thuringiensis*, which was described in 1900 by Berliner, is now utilised for biological control. The commercial preparation in the form of dusts/sprays are available in some countries. Viruses (NPV), fungi and nematodes are also being used as microbial control agents. In the USA, the bacterial agent *Bacillus papilliae* (milky spore disease) has been shown to be quite effective in the control of Japanese beetles and numerous cater-pillar pests. The use of nuclear palyhedrosis virus against *Spodoptera* sp. *Heliothis* sp. and *Amsacta* sp. are being explored in India.

Use of inert materials for insect control—The use of activated white koolinite clay at 10 gm/kg of seed-protected cowpea, bengalgram and sorghum seeds from damage by stored-grain insects for a year without impairing their germination. The cost of treating 1 kg of seed is about twenty paise.

Use of oil—The method of treating pulse seeds with either coconut, gingelly, groundnut or neem oil at 1% dosage afforded protection from pulse-beetle attack for one year (personal communication by junior author).

Use of plant product—Spraying twice neem-seed kernel extract 5% with 1% soap on bengalgram at pod-forming stage at 15 day-intervals recorded the least pod-borer damage (2.10%) when compared to centrol (25.12%). The cost of treatment/ha was only Rs. 81.25 which resulted in an additional yield of 692 kg/ha and a net profit Rs. 956.75/ha.

The use of neem oil and neem-seed kernel extract against Brown Plant Hopper of rice has given encouraging results. Neem oil at 20 ml/litre gave 69.20 and 90.30% reduction of plant hoppers 2 days and 7 days after spraying respectively. Neem-seed kernel water-extract (50 gm/litre) gave 76.70% reduction seven days after spraying (personal communication by junior author).

Use of light traps—In order to reduce the intensity of insect population light trap may also play a role. Many types of light trap are now available.

Irradiation—In insects, egg stages are highly radio-sensitive and require much smaller dose to cause irradiation injury as compared to larva, pupa and adult. The stored grain, when irradiated, are protected from pests and quality is improved for considerable time.

Chemosterilisation—Chemosterilants are chemicals when appllied orally/sprayed/injected to insects would deprive it of the ability to reproduce. These chemicals cause sterility by preventing the development of sperms or ova. *Apholate* and *Matapa* are being tried as sterilants in India.

Use of sex attractants/pheromones—Insect pheromones are defined as chemical substances which are secreted outside by insects and received by other insects of the same species in which they initiate a specific reaction. In control, these compounds are used as attractants or lures and are, therefore, also termed as sex-attractants/sex-lures. Sex pheromones of 40 insect species have been identified so far. Now-a-days, commercial quantities of synthetic sex-attractants are readily available for economic insect control. These are different types of sex-lure traps.

Use of juvenile hormones—These are chemicals, which under specific conditions, can cause abnormal growth or behaviour patterns. They are also being explored.

Use of anti-feedents—These compounds prevent insects from feeding on treated foliage without killing or even repelling them. These compounds can be regarded as inhibitors of gustatory reflexes or as feeding detterants. Pyrethrum, Neem seed (*Azardictin*) ; *Organo tins* ; Triphenyl hydroxide ; Triazenes ; AC 24052 ; Miscellaneous : Cycocel, copper stearate are important anti-feedents that are being tried in the country in pest management.

Need-based use of pesticides—As stated above, regular monitoring and surveillance of pests are essential. This will enable us to apply pesticides judiciously. Although pesticides may be important in IPM programmes, they represent only one of the elements that can be used for maintaining pest population at acceptable levels. It is often stated that they can be easily and readily applied in a wide variety of situations, but in this respect, the need for sufficient expertise and improvement of application techniques should be stressed to avoid misuse and overuse. Careful selection is essential to avoid unwanted interaction. The objective of application of pesticides is therefore to maintain the pest level below the threshold limit.

Need for Education and Extension in improving IPM

The "lag-time" between research results, extension demonstration and farmer acceptance my be decreased if conventional chemical control methods are failing or if intensive technical assistance is provided to growers.

Scouting of the fields by unemployed students will need a new type of curriculum and these students might be employed by farmers to make the pest population and crop-damage assessments needed to make proper control decisions.

In many plant-protection services, the levels of training and specilization are not sufficient. Extension services in plant protection have to face a heavy task and are often understaffed. Education and training should be carried out increasingly in developing countries. This requires an integrated action programme from governments and universities in the area of education ; Post-graduate research with emphasis on extension services. Candidates from rurual areas (children of farmers) should be given access more easily to secondary education facilities and universities.

There is a great need to strengthen agricultural extension services, particularly plant-protection extension, so that these can participate effectively in adaptive research, demonstrations, and in a variety of ways to ensure that the progressive ideas from research are put into farm practice.

IPM does not offer an instant panacea for the problems of pest control, but is rather an approach through which desirable change in plant-protection practice can be mediated and directed. Since this is an essential component in the increase of agricultural production vital to all developing countries, it is desirable that all governments and organisations develop policies and practice favourable to the development of IPM.

The effectiveness of IPM has been and must be demonstrated on the basis of increased profitability of the farmer's crop production efforts. Such profitability should be considered in a broad sense and includes monetary gains, mainly through reduced cost of crop protection inputs, re-establishment of production security and minimising the environmental impact. In this respect, it should be emphasised that IPM is continuously evolving and, hence, required sustained research and development efforts and continuing support.

The degree to which various components will be used in IPM programme will vary between crops and areas, depending on the crop/pest environment and the socio-economic conditions. However, the ultimate structures of the different programmes will have many similarities.

Training needs in improving IPM programmes

Development and successful implementation of IPM very much depends upon increased education at all levels. The basic educational programme should be varied in scope and format and designed to cover the full spectrum of IPM. Old-training programmes will have to be revised and expanded and new programmes designed 'to provide the necessary education for all levels involved in IPM. Special efforts will be needed to provide a system of continuing education for those involved.

One of the greatest constraints to the implementation of IPM is the lack of confidence on the part of the farmers that they can implement the IPM system without undue economic risks or serious loss of production. This must be overcome by specialised education for the farmers and the technicians who advise them. In many instances, this will probably require intimate knowledge of how the farmers make his decisions and the training then designed around the process. The research and training programmes must be adequate to create the necessary infrastructure to develop and implement IPM programme.

Role of National Remote-Sensing Agency in Pest-Management Studies

So far no systematic work on the use of remote-sensing on rice insects and diseases has been done. NRSA (National Remote-sensing Agency) has attempted to detect and identify through satellite data the large area infested with BLB in 1980 in Punjab. Remote-sensing techniques are needed to determine the presence of rice insects, diseases and other causes, such as insects ; BPH, GM, Stem borers, Rice bugs, Leaf folders, Army wonns, Tungro, BLB, Rice blast.

The present ground-surveillance is laborious and time-consuming. Its coverage of large areas will allow timely preventive and control measures. In addition, remote-sensing can make it possible to detect not only the population of pests before they reach economic injury levels, but also insect migration and movement of pathogen spores. This information, when supplemented with agro-meteorological data, may provide a faster and more accurate method of forecasting pest build-ups than the traditional ground methods.

Popularization of IPM in the country

To propagate and popularise the IPM technology among the farmers, the Directorate of Plant Protection, Quarantine and Storage with the help of its field stations (Central Plant Protection, Surveillance and Biological control stations) have laid out, IPM demonstrations at 10 centres in farmers' paddy fields in a compact area of 100 acres each during 1981-82 and 1982-83 at Pathankot (Punjab), Karnal (Haryana), Gorakhpur (U.P.), Guwahati (Assam), Cuttack (Orissa), Bilaspur (M.P.), Khopoli (Maharashtra), Hyderabad and Eluru (A. P.), Tiruchirapalli (Tamil Nadu), and Ernakulam (Kerala)—in collaboration with the State Departments of Agriculture, Agricultural Universities and the ICAR[2]. An action-plan to lay out the demonstrations has been prepared and circulated to all coordinating and collaborating field stations.

Favourable factors regarding IPM Philosophy

(i) IPM is definitely a full-fledged technology by itself for the management right from initiation of crop to the harvest with positive and favourable results.

(ii) Both in terms of reduced cost of pest control and higher yield, technology for rice IPM is available in the country which is being utilized in this programme.

(iii) The last six-years' demonstrations have shown favourable results in terms of reduced cost of pest control and increased yield in the IPM areas compared to non-IPM plots.

(iv) Apart from the results, the education of farmers to be attained to this type of technology in the crop production especially in rice, itself is a big achievement.

(v) A convinced man/farmer is the best promoter of this technology than any other publicity or propaganda.

(vi) The IPM also helped in reducing the pesticide used and consequently reduction in the pest resistance to pesticides, residues in the soil and crop and prevention of environmental imbalance, health hazards and pollution.

Constraints in implementing IPM

(i) Awareness of farmers on aspects of pest and pest control is still a problem to overcome. IPM concept is sound but difficult to implement. Successful IPM implementation might be achieved by relatively highly educated farmers. The concept of economy and the harmonious blending of several compatible-control techniques are complicated task for farmers, especially in the developing countries. Farmers do not talk about theory of IPM, agro-ecosystem, pest status, side-effects of pesticides, or host-parasite relation for instance. They talk about what happens now, development and implementation of IPM concept requires time and patience.

(ii) Most progress in selecting varieties resistant to certain pest has been made in small isolated plots, greenhouse or in other non-natural conditions This may be a correct procedure, but before the introduction of this material into general practice, especially when considered in connection with integrated control, atleast two questions have to be answered. Is the factor on which the resistance is based, really important factor in the over-all regulation of the population numbers ? Does the introduction of this factor have a negative effect on any other main regulation factor ? We have in mind especially the interaction with predators and parasites.

(iii) Though IPM technology in rice-pest management is available, the shortage of multiple-resistant varieties of rice is a felt-need.

(iv) It is also one of the felt-needs that selective pesticides against pests of crop but safe against the natural enemies are still not available/identified.

(v) One of the basic points of IPM is economic threshold level which is not worked out for each pest or combination of pests for different varieties and regions.

(vi) Precise pest-surveillance/monitoring methods have not been standardised, besides forecasting and forewarning of pests and diseases.

(vii) The techniques of mass rearing of potential parasites and predators of rice insect-pests are still not developed.

(viii) The average Indian (farmer), by and large, is not highly educated and has a different set of socio-cultural environment which is really a constraint in introducing any new technology or innovation or ideas. As such, a few examples of demonstrations here and there in the country may not make any dent in the acceptance of this programme by the farming community of the country. Perhaps, slowly and slowly, this may catch up by increasing the demonstrations followed by extension programme in each block or so. There are about 5,000 blocks in the country.

(ix) Average Indian farmer's economy is not sound to apply all the techniques involved in this programme right from management to purchase of resistant seeds, application of fertilizers, pesticides, etc.

For achieving success in pest management, a precise understanding of the latest crop-management technology consisting of surveillance of crop pests, use of resistant varieties, adoption of good cultural practices, use of biological control methods, anti-feedents, pheromones, irradiation techniques, microbial agents and need based application of pesticides as a last resort have to be adopted.

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DRUG RESISTANCE IN MICROORGANISMS—A REVIEW ·

TAPAS K. DAS* AND A. K. BANERJEE**

Resistance has been defined as the temporary or permanent capacity of a cell and its progeny to remain viable or to multiply under conditions that would destroy or inhibit the growth of other cells[1]. Drug resistance of pathogenic organisms has posed a serious challenge to the medical science and has called for a continual introduction of more and new effective chemotherapeutants. But this has only led to the escalation of the resistance problem, rather than to its solution[2].

Though experimental studies on drug resistance began on protozoa before the turn of the present century[3], the clinical significance of the phenomenon became clear only after the advent of sulfonamides and antibiotics.

Origin of drug resistance

Most mechanisms of drug resistance of microorganisms are based on genetic changes that alter or induce specific proteins[2]. The mechanisms involved in drug resistance are :

(a) Enzymatic detoxification of the drug.

(b) Genetic alteration of the susceptible enzyme resulting in loss of binding affinity with the drug, or of any other protein factor necessary for its synthesis, or of a ribosomal RNA.

(c) Alteration of membrane proteins leading to decreased permeability of the drug.

(d) Increased production of a drug-sensitive protein to overcome inhibition by the drug.

(e) Increased production of a metabolite that antagonizes the antibiotic.

(f) Introduction by a plasmid, etc., of a gene eucoding for a bypass to a blocked metabolic step.

(g) Diversion to an alternate pathway circumventing drug induced block.

Resistance plasmid

Until 1960's it was assumed that drug resistance of bacteria was due to spontaneous mutation and selective multiplication of the resistant mutants in the presence of the drug. But the possibility of occurrence of multiple mutations on the chromosome of a single bacterial strain which could result in resistance to a number of drugs at the same time was least likely to occur in nature; a simple mathematical computation rules out such a possibility[4,5]. Moreover, it was observed that drug resistance in many cases was infectious, involving a process whereby the resistance to a number of drugs could be transferred at one stroke from a resistant to a sensitive bacterial strain. The genetic determinants for such

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multiple resistance were carried on a plasmid (R-plasmid) which like the sex factor, was able to promote its own transfer. In these R-plasmids the drug resistance gene(s) was often associated with a transfer factor. The transfer factor and drug resistance genes could also segregate from each other[6,7].

R-plasmids are distributed both in Gram-positive and Gram-negative bacteria. In most strains of staphylococci the genetic determinants for penicillinase[8] and resistance to macrolids and aminoglycosides are plasmid mediated[9]. In streptococci too, transferable plasmids for resistance against tetracyclines, chloramphenicol and macrolids have been detected[10-12]. Antibiotic resistance in *Clostridium perfringens* is also due to R-plasmid[11].

R-plasmids have also been shown to be responsible for drug resistance of most of the clinical isolates of Gram-negative bacteria e.g. *Shigella, E. coli, Klebsiella, Proteus, Citrobacter*[4,6,12,13], *Achromobacter*[14], *Pseudomonas*[15], *Pasteurella*[16,17], *Vibrio*[12,13], *Yersinia*[4,12,13], *Haemophilus influenzae*[18-20] *Neisseria gonorrhoeae*[21] and *Bacteroides fragilis*[22].

Incidence of antibiotic resistance

Multiple drug resistance was first observed in Japan in 1955 in a subborn case of dysentery caused by *Shigella*. In the next few years the incidence of multiple resistant Shigellae in Japan increased remarkably and among the total isolates their frequency rose from 10% in 1960 to more than 50% in 1965[23] Similar increases were also reported from Great Britain[24].

A parallel situation prevailed in *Salmonella*, where resistance to 6 or more antibiotics in the United States increased dramatically from 0.8% to 9.2% between 1967 and 1975[25]. In India too, multiple drug resistant strains if *S. typhi* and other serotypes have been reported[26-28]. An alarming increase in multiple drug resistant *S. typhimurium* in Southern India has been reported[29]. All such strains were belonged to the phage type, 66/122/UT[30]. This phage type carrying plasmid mediated drug resistance has been found to be the causative agent of widespread outbreaks in many countries[31].

In a similar way, drug resistance in enteropathogenic strains of *E. coli* has increased significantly[32]. The resistance pattern differed in the isolations. While Barua[33] found that all enteropathogenic *E. coli* strains, isolated from a single epidemic belonged to a single serotype and were resistant to streptomycin, penicillin and erythromycin, but sensitive to chloramphenicol and neomycin, Shah[34] found different patterns of antibiotic sensitivity of enteropathogenic *E. coli* isolates. One of the strains (*E. coli* O 128) was resistant to erythromycin, ampicillin, streptomycin and tetracycline while the other (*E. coli* O 111) was resistant to only furadantin. The other enteropathogens (*Pseudomonas aeruginosa, Sarcina ventriculi, Shigella* spp., *Salmonella amstardam* and *S. typhi*) were found to be resistant to one or more antibiotics[34]. In an exhaustive survey Alam[35] isolated about 3000 strains of enterobacteria and pseudomonads, from clinical samples derived from patients suffering from genitourinary and nosocomial infections and found roughly 34% of the strains to be drug-resistant. Among these isolates 456 were *E. coli*, 182 *K. pneumoniae*, 103 *P. vulgaris* and 261 were *Ps. aeruginosa* strains. In general, a significant portion was resistant to ampicillin, chloramphenicol, streptomycin and sulphanilamide and sensitive to other tested antibiotics, except an aberrent behaviour towards penicillin. This figure was slightly higher than what was reported from Japan in 1970[12]. However, the percentage of drug resistant strains in clinical isolates in Japan has later considerably increased[36].

The high incidence of multiple resistance in hospital-acquired infections has been widely documented[1,37]. But perhaps the most ominous feature is the emergence of resistance in *Haemophilus influenzae*[18,38-40] and *Neisseria gonorrhoeae*[21]. The sequential appearence of resistance in *H. influenzae* against ampicillin, tetracycline, tetracycline and chloramphenicol and kanamycin has been particularly dramatic because surveys prior to 1974 never showed the presence of a single resistant isolate[19].

There has been a change in the antibiotic resistant pattern of staphylococci also as reported by several workers[41,42]. A gradually increasing resistance to penicillin, to penicillin and streptomycin, to tetracycline and even methicillin in staphylococci in hospital environment in India has been reported[42]. In a more recent survey[43], the percentage of resistance in 170 strains of staphylococci isolated from clinical materials was as follows : penicillin (40.4%), ampicillin (36.5%), streptomycin (26.5%), tetracycline (19.2%), methicillin (14.1%), erythromycin (12.8%), chloramphenicol (7.7%), Co-trimoxazole (2.6%) and gentamicin (1.3%). In this study comparison of multiple drug resistance pattern between in-patient and out-patient strains showed a higher incidence of drug resistance in the former group.

Bacteria resistant to various antimicrobial drugs have been isolated also from a variety of aquatic and terrestrial habitats. Generally, bacteria with the greatest levels of resistance have been isolated from environments with the greatest potential for contamination by antimicrobial agents e.g , effluents from hospitals, domestic houses and cities[45,46], commercial fisheries[47] and abattoirs[48,49]. Smith[50] isolated large number of resistant coliforms in England from river water into which improperly treated urban sewage was being discharged.

Isolation of drug resistant bacteria even from apparently more pure environment is also not uncommon. Thus, presence of resistant *Klebsiella* in plant environments[51], *Aeromonas hydrophila* in estuaries[52], *Vibrio* spp. from oil fields in gulf of Mexico[53] in marine sediments[54] and even in drinking water[55].

Similarly, water samples from a section of the river Ganga (Katwa, West Bengal) which was found to be relatively free from pollution was found to harbour a fairly rich microflora, including some potential human pathogens[56]. Altogether a relatively low proportion (about 3%) was found to have multiple resistance to the five test antibiotics—benzylpenicillin, streptomycin, chloramphenicol, tetracycline and gentamicin, about 28% exhibited resistance to one or more of them. Among the different groups of potential human pathogens, the proportion of resistant strains was still higher, the highest being in the *Salmonella—Shigella* group (about 87%) [T. K. Das and A. K. Banerjee, unpublished results].

The above findings point to show that the frequency of resistant organisms in the over-all biosphere is on the increase[57] and is assuming an alarming proportion over the years as more and more new agents are introduced giving rise to only more new problems of resistance[2]. The word of caution pronounced by Lowbury and Ayliffe[58] that, "we have good reason to be anxious about the future—if we do not device and adopt better ways of arresting the trends towards resistance than those in current use" can hardly be considered as an overstatement. ☐

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NUCLEAR POWER—IS IT THE ULTIMATE ANSWER ?*

B. B. BALIGA†

IN the world today, energy has become synonimous with progress. The advancement of any society is measured in terms of the units of energy consumed per capita by its members. Our sources of energy in the first half of the present century, and to a greater extent even today, are based on fossil fuels, stored by nature for millions of years. All the fossils fuels are solar in origin, laid down over very long periods of time, and stored in what are essentially static storage media that require the calculated intervention of man, if they are to be unlocked. Coal is the most static of these, the natural gas the least and oil somewhere in between. As these stocks were built over millions of years and at times when nature was not interfered with man's activities, replenishment is out of question and the rapidly dwindling stocks have made man look for new sources of energy for keeping pace with his progress and may be even for ultimate survival on earth. Thus several non-conventional energy sources are being talked about and experimented with for the last two decades or so.

In a true sense, all the energy but that derived from the tides and geothermal sources is nuclear in origin. The latter term is derived from the splitting or fusing of atomic nuclei among the elements left on earth by whatever extraordinary processes created it. Solar energy itself is created by nuclear fusion, radiated across space and sometimes stored in such media as coal, oil and water, sometimes not. What we call biomass today are also derived from solar radiation stored for the short term in the media. Also solar are the forms or energy that depend upon the weather, such as wind and hydropower. Here the storage media is air and water. Finally there is the direct solar radiation which can be captured as heat or converted to electricity.

The maximum flux of solar energy, in the best of conditions, is about one kilowatt per square meter. If this is to be concentrated it must be done over geological life spans, as in the case of fossil fuels, or over immense land areas, as in the case of watersheds that serve hydropower. The flow of solar energy is dilute and intermittant and its storage on a large scale is difficult and expensive. It is this sort of solar energy, renewable but diffuse, that most people have in mind when they use the term.

In this background let us consider some imperatives for our future use of energy. To do so our assumption is that we owe a primary obligation to ourselves and to our immediate progeny, and a very strong secondary obligation our more distant posterity.

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*Based on a talk given on AIR during May/June 1989.

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The first imperative is that energy is made for man and not man for energy. We do dot live for the purpose of using any particular energy system or manifestation of it.

Secondly, we owe to our posterity access to petroleum, coal and natural gas, not merely as fuels but as chemical feedstocks. We can not justify burning any of these fuels except on the ground that some very serious harm may come to us otherwise. Even if we could regard our coal as a resources properly to be burnt under the best of circumstances, in a foreseeable future, its use will be occupationally dubious and environmentally disastrous.

The various alternative sources of energy, which we roughly grouped as solar, can make some contribution to our energy needs, but neither severally or singly are they an answer to our problem.

When we use fossil fuel we ought to use them in the most reasonable fashion. Thus for example, we have devised or devising substitutes for petroleum in all types of transportation other than aircraft. This should lead us to such programmes as the electrification of railways, to be run on electricity generated from the atom, as well as to projects to electrify as much of our automobile use as possible. Such conversions are proposals to save fossil fuel resources that will certainly be needed by our remotest imaginable descendents and to spend nuclear resources. Similarly natural gas, burning as cleanly as it does and comparatively so easy to transport, is well adopted to certain uses—such as cooking—hence its use should be discouraged outside those areas.

The inference to be drawn from this discussion is that nuclear energy, far from being an outcast among resources, ought to be the energy source of our choice, for all uses for which electricity is suitable intermediary. It does not matter whether electric generators waste heat, if they waste heat from abundant and otherwise useless uranium and thorium. Wastage is, afterall, the misuse of something that could be better used otherwise. On the other hand, any use of oil to generate electricity is entirely waste. The same is true for all fissile materials unless we regard nuclear explosions to be more provident use of such materials than in the power reactors.

The major risk posed by a nuclear plant is the presence of fissionable material in the core of the reactor. Yet it will be meaningless to consider the risks associated with nuclear energy in isolation. They must be compared with other energy sources. Nuclear wastes are dangerous because of their radioactivity. But the radioactive waste which is harmful today will not be so after a certain amount of time. While chemical wastes which are dangerous to-day will remain so. One may say that radioactive waste has life of hundreds of years. But it should be realised that larger the life time of radioactive waste, the smaller the specific radioactivity at a given time. There are ways of storing very high radioactive wastes under conditions that are perfectly acceptable.

Thus in the foreseeable future, nuclear power is the only answer that can meet most of our demands. Hence while considering alternative energy sources one should also consider alternatives in nuclear energy. Great progress has been made in producing nuclear energy since its discovery in the forties. No one can think of deriving new and larger supplies of electricity from conventional reactors which wasted most of uranium put into them for most of it neither fissioned directly nor transmuted to plutonium. This is not a serious problem given world uranium supplies, but any serious expansion would lead to difficulties of supplies. Over the last forty years intensive research and constant innovations have allowed the nuclear technology to emerge anew to meet the energy demands of the world. The Superphenix breeder reactor of France, the high temparature gas cooled reactor of the United States or the Slowspoke of Canada have emerged as the new leaders to meet the growing demands of energy.

Further in the future are the fusion reactors. These latter devices are expected to give us essentially unlimited energy. Or are we going to find out that operable fusion reactors can never be made to be economic or indeed to function ? In any way they remain a glittering promise and development towards them is proceeding on schedule. □

S. K. Mitra—II

SCIENCE SERVICE*

S. K. MITRA

MY first duty – a very pleasant one – is to welcome our Chief Guest, Professor Humayun Kabir, Professor Kabir is one of us. For a long time he had been a colleague of many of us here in the Post-Graduate Departments of the University Besides being an educationist and an administrator, Professor Kabir had a distinguished political career, and is also a writer of repute both in English and in Bengali. His literary criticisms, fictional works and philosophical writings show his sympathetic mind and keen insight combined with breadth of outlook. I would commend you to read two of his recent publications 'Education in New India' and 'Science, Democracy and Islam' and also his latest one 'Student Unrest : Causes and Cure'. For this Annual Meeting of the Indian Science News Association, whose main activity at present is the publication of the journal *Science and Culture*, we could not have chosen any one better than Professor Humayun Kabir, Minister, Scientific Research and Cultural Affairs, as our Chief Guest. It is extremely nice of him to have accepted our invitation notwithstanding his multifarious engagements.

For information of our Chief Guest I may mention that the *Science and Culture* was started in the year 1935, the same year as that of the foundation of the Association—mainly through the efforts of the late Dr. M. N. Saha —to promote, popularize and disseminate the knowledge of natural and cultural sciences.

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* Being the text of the address delivered at the Annual General Meeting of the Indian Science News Association on September 30, 1958.

The objects for which the *Science and Culture* was started remain as important as, nay more so today than, what it was 23 years ago. This is because scientific discoveries and technological inventions have been proceeding so fast in recent years that it is becoming increasingly difficult for the understanding, not only of the common man but also of the leaders and administrators, and sometimes even of the scientists themselves, to adapt itself to their significance and implications. As illustrations I may recall the following technological developments and scientific discovery made in course of only the last decade : Perfection of mechanization by electronic methods –Automation—has ushered in a second era of industrial revolution; launching of the sputniks has inaugurated the age of space travel; production of temperature of the order of million degrees in the laboratory—temperature at which matter is burnt into energy in the sun and the stars, has opened up the possibility of producing power from sea-water; and the discovery last year by two Chinese American scientists—which, by the way, won them the Nobel Prize—that the Creator is not always impartial and even-handed in his creative work, being sometimes left-handed, specially for weak cases, has shoked the scientific world. The scientists hitherto naively believed that the Creator had no preference for the right or the left, choosing the one quite as often as the other. And I may refer also, though not exactly a discovery or an invention, to the results of immense importance to science and to our every day life on earth that are to accrue from the 60 nation giant scientific enterprise, the International Geophysical Year, undertaken with the object of knowing more about the planet we live in and its environments. All such technological developments, scientific discoveries and international enterprises are of profound significance to Man. How can the intelligentsia of the country—from whom the leaders emerge, be made conscious of their socio-economic and cultural impacts ? I use the word leader here in a broad sense, meaning not the political leaders only, but any one who gives guidance to his fellow man, a teacher in his village, a committee chairman for the time being, an executive head or, for the matter of that, any one who had the privilege of formal education *vis-a-vis* those who had no such privilege. The first step to awaken this consciousness must be through education by making the educational programme of the country broad-based. By broad-basing I mean doing away with the age-old division of the field of human knowledge into two sections—science and humanities, by recognizing their basic unity. Courses on humanities are then to be interspersed with courses on science subjects and *vice versa*. This is to be done not only in the secondary school stage, but also in the university stage and in the technological institutions. It is only by this means that can be countered the dangers inherent in over-specialization by depth of study which, not infrequently, develops a rigid, unreceptive frame of mind. It is sometimes said that science develops its own cultural values. That may be true, but that should not make us oblivious of the great field of knowledge and inspiration represented by humanities. If science imparts discipline of thought, humanities endow the mind with flexibility essential for adapting oneself to one's changing environments.

One is glad to note that steps for broadening the educational base have already been taken in many of the States of the country by the implementation of the Mudaliar Commission Report on Secondary Education. In the State of West Bengal, in all the new 11-year Higher Secondary schools, a student whether he elects for the Science or the Humanities or the Technical group, has to take compulsorily courses on Social studies (an integrated composite course on History, Geography, Civics and Human Relations) and on General Science. In the existing 10-year schools, the courses hitherto included subjects in the humanities group only. To this has now been added a general science course for all. I am not aware if similar liberalizing of curricula is being attempted in the University stage also in the country, though, courses on selected subjects in the humanities have been introduced in all the new technological and engineering institutions.

Along with the liberalization of the educational courses, there must also exist means of communicating--conveying in language intelligible to the non-specialist--information regarding the latest progress in science and technology, both to high quarters, political leaders, legislators, administrators and top executives as also to the average educated public. And it is here that a journal like *Science and Culture* is of great value. It serves, on the one hand, as a vehicle of communication as described above and on the other, suggests how fruits of science --science of today being technology of tomorrow-- may be utilized for national welfare. We can justifiably claim that *Science and Culture* has been doing this very important service for nearly a quarter of a century, though the standard may not always have been such as to give the fullest satisfaction to its promoters. This is due mainly to the many restrictions under which we have to work. For example, for a long time, the responsibility of editorial work of the journal rested on voluntary shoulders. This, we found from experience, was not always satisfactory. Recently, therefore, we took the step of appointing paid staff for the work, though, of course, the editorial policy and general guidance remain in the hands of the Editorial Board, the membership of which is honorary. The appointment of the new paid staff for editorial work has, however, put additional financial liability on us and to meet this, as also for general improvement, we have increased the advertisement rates. But, this is not found to be enough; the liabilities cannot be met without further monetary aid and for this we have approached the Government.

Regarding the future of our Journal, I am optimistic. I am reminded, in this connection, of what Dr. Saha often used to say. He had once met the late Sir Richard Gregory, then Editor of *Nature*, and was informed by him that it took a journal like *Nature* 30 years to attain the status of a successful magazine. Dr. Saha would, therefore, advise us to be patient, 30 years being a long enough time to set one's house in order, adding that if we, on our part, made honest and sincere effort success was bound to come. *Science and Culture* is now in the 24th year of its existence. In 6 more years it will attain the age of 30. We firmly believe that within this time, if not earlier, it will grow up to the stature that was expected of it by its founders. ☐

From October 1958 issue of *Science and Culture*.

OBITUARY

MICHAEL EVENARI

(alias Walter Schwarz)

1904-1989

Michael Evenari, an outstanding ecophysiologist, a world authority on seed germination, a competent specialist on arid-zone agriculture and the doyen of Israeli botanists, breathed his last on April 15, 1989 in a Jerusalem hospital.

Michael Evenari

He was born in 1904 in Metz which, though under German rule, modified the French character of the town. His father, the Jewish merchant Hermann Schwarz, called him Walter—a name symbolising his addiction to German culture. When France won back Alsace-Lorraine in 1918, Hermann opted for German citizenship and moved with his family to Frankfurt-am-Main where young Walter went to high school In 1923, Walter enrolled at Frankfurt's Johann Wolfgang Goethe University and majored in botany. He received his basic training in botany from Martin Moebius, the Head of the Department, and the fundamentals of plant physiology from Fritz Overbeek, the sole assistant in the same department. At the age of 22, he obtained his Ph.D. and then served for two terms as an assistant to Moebius. He worked on the physiological anatomy of the fruit stalks of heavy fruits. He probed intricate problems on developmental physiology such as chimeras and the origin of variegation in plants.

Walter pursued his studies at the German University in Prague where he was offered a job as assistant to Ernst Pringsheim. His sojourn (1928-31) there widened his botanical outlook greatly and he became interested in floristics and phytosociology. In 1931, he left Parague to continue his research first under the geneticist Friedrich Oehlkers and later under the ecophysiologist Bruno Huber at the Technical University of Darmstadt. He not only became familiar with the genetical aspects of developmental physiology but also followed the structural changes in leaf cuttings ; the latter contribution fetched him the coveted licence of academic lecturership in 1933. His brilliant start to a respectable career as a botanist was nipped in the bud by untimely dismissal at Darmstadt and the Nationalist-Socialist discrimination forced him to leave Germany for good. The German patriot Walter Schwarz, who had already published 17 scientific papers, ceased to exist, being replaced by the fighting Jew Michael Evenari who ostensibly commenced as a newcomer to science in a new land when he accepted an assignment at the herbarium of Aaron Aaronsohn at Zikhron Yaakov, Palestine. This work provided him the opportunity to survey the flora of the Near East and to prepare the *Florula Cisjordanica.*

Fascinated more by experimental work, Evenari soon settled down in Jerusalem and associated himself with the activities of the Hebrew University's Botany Department. He investigated transpiration, water deficits and stomatal reactions but also the morphology of the root system and the inner structures of stems and leaves and their adaptive features to the harsh conditions of his new homeland. Co-operating with David Zirkin, the veteran nurseryman at Kibbutz Ein Kharod, Evenari improved the rooting of grapevines by plant-growth substances and the sprouting of potatoes as well as the seed germination of apples and plums by application of low temperature. He devised new ways to force early flowering of *Iris* bulbs and to break the rest period of *Gladiolus* corms.

But Evenari's budget was exceedingly poor and the University authorities kept him in the lowly rank of a Lecturer for a decade (1934-1944). Two of his gifted assistants—Ephraim Konis and Gershon Mosheov —suffered a premature death. In order to earn money for immigrating relatives, he even taught botany in secondary schools. During the riots of 1936-39, he became a passionate member of Haganah, the Jewish self-defense organisation, and had to participate in guard duty two or three nights per week in one of the Jewish suburbs of Jerusalem. In 1940, he volunteered for the British Army. Joining the Palestine Light Anti-Aircraft Battery, one could find him on the roof of the Haifa Railway Station where the Tommies called him their professor. Even as a soldier, he managed his time to botanise in Cyprus and Italian alps.

After demobilisation in August 1945, he returned to Palestine and continued with his physiological-agricultural research upon receiving the long overdue promotion as Senior Lecturer. But he devoted most of his time in the service of Haganah, as the country was in turmoil. Since the finances of the Hebrew University were in doldrums, he was deputed to South America and the United States to mobilise funds from the Friends of the Hebrew University for the University's upkeep. He was granted a year's leave of absence and spent his sabbatical (1949-50) at the California Institute of Technology, Pasadena, Calif. He soon befriended Frits Went, but the man who had the greatest impact on his work was James Bonner. Upon his return to the nascent State of Israel, he climbed the traditional ladder to the Chairmanship (1951-53, 1959-70) of the Botany Department and to an untraditional vice-presidency (1953-59). He was a guiding force behind the construction of the new campus of the Hebrew University at Givat Ram after the partition of Old Palestine denied the Israelis access to their Mount Scopus campus. Distinguished guests poured into his laboratory and his young colleagues were sent abroad. He was led to a close co-operation with American research institutions and international agencies.

Having become disenchanted with administration and strongly supported by his dedicated second wife Liesellote Evenari, he gave up all administrative positions in 1971 and reverted to his professorship so as to devote all his energy and time on the Avdat farm which served as a proving ground for modern means of reclaiming arid zones. He demonstrated that what man did successfully three thousand years ago can be repeated even today (*Sci. & Cult.* 38, 265, 1972). The basic aim was to convert the annual rains which fall in the winter storms to many times the quantity of downpours (*Sci. & Cult.*, 38, 101, 1972). The little farm ($2\frac{1}{2}$ ha), laden with heavy vines, golden apricots and peaches, almonds and pistachio trees, juicy loganberries, waving sunflowers, luxuriant onion and asparagus, give the lie to the parched surroundings.

The Avdat farm, once started as an agricultural project, was turned into "a research station for the ecophysiology of desert plants and cultivated plants growing under desert conditions, and for the investigation of structure and function of desert ecosystems" (*Annu. Rev. Plant Physiol*, 36, 1, 1985). Evenari was joined by a team from the University of Wurzburg -Otto Lange, Detlef Schulze, Ludger Kappen and Uwe Buschbohm -who arrived at Avdat with sophisticated equipment for measuring *in situ* transpiration and photosynthesis. They investigated the influence of different levels of salinity on transpiration, photosynthesis, ion uptake, water and osmotic potential, biomass and fruit set of pistachio tree; also various degrees of salinity on composition and structure of soil. The results were published in more than 30 papers and the experiences at Negev Highlands before and after the work was complete, were summarised in a book (Evenari, M., L. Shanan and N. Tadmor 1982. *The Negev: The Challenge of a Desert.* Harvard Univ. Press, Cambridge, Mass., USA, 2nd edn.).

In 1974, Evenari became Professor Emeritus at the Hebrew University and was engrossed in research on white-green variegated plants as well as kept busy writing an autobiography of his eventful life. His academic achievements brought him many awards and laurels. He was elected a Fellow of the Linnean Society of London and corresponding Fellow of the Botanical Society of America. He was a Honorary Member of the German Botanical Society and the American Society of Plant Physiologists. He was awarded Golden Ph.D. by Frankfurt University (1976), Ph.D. by Technical University of Darmstadt (1978) and by Ben-Gurion University of the Negev (1983). He was the recipient of Bublick Prize (1979) by the Hebrew University, Israeli Prize in Science (1986) by the President of Israel and the Balzan Prize in Plant Science (1988) by the President of Italy.

My association with Evenari dates from July 1968 when I joined his laboratory as a Post-doctoral Research Fellow of the Hebrew University.

Evenari travelled far and wide including India—a country close to his heart in December, 1970 and March, 1971. Among other things, he was thrilled to visit the Bose Research Institute of Calcutta and delivered a scintillating lecture on the ecology and physiology of seed dormancy in arid-zone plants at the Department of Botany, University of Delhi, on the occasion of the Golden Jubilee of the Indian Botanical Society.

Evenari's impetuous life was a true expression of his character. He was not only an intellectual giant, but he also had a dynamic and magnetic personality. Though passionate, he evinced patience, self-control and *sang-froid.* Although he was ambitious, he was very modest in the appreciation of his own merits and was amiable disposition. His was "one of the pioneering minds who believe in their power of reason and in creative work, and in their dominant role in the solution of World wide problems" (*Israel J. Bot.*, 13, 47, 1964). He died full of years and honours. He is survived by his second wife, a son by his first wife and a step daughter. May his soul rest in peace. ☐

S. C. Datta

Notes and news

High-rise buildings

Since the collapse of a multi-storey building at Bhowanipur probably as a result of bad-quality concrete and other building materials, the Chief Minister ordered the stalling of other multi-storey buildings under construction pending further investigation. Will Calcutta be a jungle of concretes ? he asked.

Although the uses of bad-quality building materials affect longevity of the building posing high risks, Bhowanipur buildinges collapsed almost unwarranted. Various natural phenomenon, human activities also affect building longevity. Today, multi-storey buildings do pose concern not only to Calcuttans but also to be world.

Erection of multi-storey buildings have got a start to overcome the space problems. If their construction is disallowed, the number of wandering people in Calcutta will further increase and the problem of slum will remain and for this reason, the improvement programme will be left buried.

Municipal services already deteriorated from times long ago by 1960s. Parallel to this disintegration was the influx of an officially estimated 2.5 million refugees between 1947 and 1971 of which over 1 lakh came in four years from 1947 to 1951. Administrative services and structure were collapsed and found totally inadequate. This led to erection of slums.

West Bengal's slum Areas Act passed in 1972 accepted the validity of slums but still the improvement programme remained unsatisfactory and residents of them are on rise. In absence of multi-storey building, congestion is likely to go up. The Governor of West Bengal recently drew attention of all concerned about these two pressing problems.

These days beggars are innumerable in the city. When British made Zamindary permanent, landless people largely came to Calcutta. Once a law was in vogue by which making a latrine in the city anywhere was punishable. Now the city is flooded with infiltrators. Discontinuity in the construction of multi-storey buildings in the city or demolishing the existing buildings for any reason whatsoever will make the problems of sheltering place too acute. Industrial establishments and private individuals will have a set-back in their interests.

But there are difficulties too as a result of land subsidence. Data collected during the last 25-30 years showed that there is about 6-9 m decrease in the reservoir pressure. Specialists confirm that further deterioration in the surface buildings can be likely if pressure drops further due to excessive lifting of undergroundwater. This will cause land subsidence and, hence, the surface buildings. This coupled with the peculiar geological set-up controlling occurrence of groundwater pose serious threats to the multi-storey buildings.

Undergroundwater has some specialities. It cannot be withdrawn as much required. The aquifer's balance is disturbed if much water is taken out A kind of vacuum is thereby created. This makes water withdrawal difficult. Land subsidence also is likely for that reason. It is reported that Calcutta has already sunk by about 30 cm in the last 25-30 years. Sinking is likely around high-rise building areas by a big margin. This is so with the South-Central Calcutta. Geologists noted that artesian pressure decreased largely in and around newly-developed high-rise building area. Overpumping for municipal water supply is the main cause for land subsidence. These may affect the surface buildings too. On the other hand, if multi-storeyed buildings do continue to exist, their safety will be a point of concern. Far from being their norms, deterioration is likely from environmental concerns and from human activities.

Metropolitan Calcutta has sunk already within 25-30 years by about 30 cm. It is said that it can sink further if extraction of undergroundwater for municipal water supply does not cease beyond control. This, in turn, can severely affect surface buildings.

Due to excessive withdrawal of groundwater, groundwater pressure falls sometime extraordinarily to cause sinking of metropolitan Calcutta. This is the case with South-Central Calcutta. Geologists gave an alarm about some regions of Calcutta. According to them, this is the main cause of land subsidence. Statistics placed by them indicated 6-9 m decrease in reservoir pressure, the maximum being in South-Central Calcutta.

Indeed, there are many tubewells which supplement city water. There are, probably, as many as 200 deep tubewells. Besides, there are numerous smaller tubewells. Various housing agencies construct these to augment water supply around the multi-storey buildings. It is reported by the geologists that the pressure decrease has amounted to 3-8 metres in a period of 25-30 years in Calcutta especially in South-Central Calcutta.

The problem is not confined only to Calcutta. It is a problem of the world. In fact, there is not a national policy with water. Only dependence on groundwater has made the problem too very complex. For faulty withdrawal of groundwater just to meet water needs has led to land subsidence of about 30 cm in several areas of the world. This is worrisome.

To arrest drop in pressure in water reservoirs of underground, specialists suggest to set up some observation wells so as to monitor pressure drops in the underground reservoirs so that artificial recharge, if required, can be made to maintain the required level of pressure. □

P. C. Bhattacharyya.

National policy on flyash utilisation

Flyash, as we all know, is an industrial waste of thermal power plants using pulverized coal as a fuel. There are about 65 thermal power plants in India; which throw away around 27 million tonnes of flyash every year, and the figure is likely to reach 70 million tonnes per year by 2000 A.D. causing serious problems of disposal and environmental pollution in addition to occupying large tracts of scarce cultivable land. Out of the currently produced amount of flyash, less than 2% flyash is utilized every year. Most of the flyash is being dumped in the vicinity of thermal power stations; and quite often let out into rivers, streams etc.

The fine particles of flyash create great nuisance to people living near thermal power stations, corrode the structural surfaces and cause respiratory diseases like silocosis, pneumonitis etc. if inhaled for prolonged period. Flow of ash into river water disturbs the acquatic life-circles.

While the developed countries have long been conscious of this industrial hazard, there has been a lackadaisical attitude in this country. Absence of organised building and construction industry in the country, high initial investment in setting up flyash-based building material industry, general apathy of material manufacturers and builders, for new technology, lack of will on the part of the Govt. to promote utilization of flyash are some of the reasons, although extensive R & D work on the utilization of Indian flyashes have been carried out since early sixties at the Central Building Research Institute, Roorkee and other research organisations in India.

Now that the country is facing acute shortage of building materials for housing the teeming millions and the consciousness of environmental pollution is growing, the Central Building Research Institute (Roorkee) has constituted a National Standing Committee on Flyash utilisation, comprising of representatives from various Central Government Departments, HUDCO, NTPC, BIS, West Bengal State Electricity Board, Cement Industry, All-India Brick and Tile Manufacturers Federation and Research Institutions. At its first and second meetings held on November 7, 1988 and April 5, 1989 respectively, the Committee discussed and evaluated various processes and technologies for commercial exploitation for the production of different building materials from flyash. At its third meeting held at NTPC, New Delhi on September 18, 1989, the following National Policy on Flyash Utilization was proposed.

(1) Suitable agency should be set up to supply dry flyash of certified quality conforming to IS : 3812 1981.

(2) Bureau of Indian Standards should be requested to formulate Indian Standards on building materials produced from flyash or incorporate suitable amendments in the existing standards to cover these materials.

(3) To eliminate transportation hazards and costs, land for setting up building materials production units should be alloted near the thermal power plant.

(4) Thermal power plants should supply flyash free of cost.

(5) Building materials produced from flyash should be exempt from various state duties/taxes for an initial period of at least up to 5 years, to encourage their production and utilisation vis-a-vis conventional materials.

(6) To generate confidence in the prospective manufacturers, demonstration-cum-production units should be set up in different parts of the country by the Govt. Agencies.

(7) A consortium of R & D Institutions, building materials manufacturers, machinery manufacturers and thermal power plants should be set up to prepare detailed engineering project reports, for setting up production units on turnkey basis.

(8) Use of flyash in reclamation of low-lying land, filling of mines, building of roads and embankments and in conditioning of agricultural land having sticky soil in particular, should be made since large quantities of flyash could be utilised in this way.

(9) Thermal power plants should have action plans integrated into their overall planning for establishing flyash based building materials production units nearest to their disposal points. □

H. C. Mital

Announcement

The Department of Science & Technology, Government of India, has commissioned the compilation of a Data-Base of Resource Persons for its Science & Society Programmes. These involve the innovative application of S & T for rural development and for the benefit of specific target groups such as artisans, rural poor, tribals, women, etc. It is proposed to "empanel" all those whose expertise and experience would be useful in such societal programmes and who have the necessary background, experience, societal understanding, motivation and willingness to *actually participate* in programme formulation, implementation and evaluation. Participation could be in different capacities and roles such as advisory, training, technical consultancy, etc.

Besides scientists, engineer, doctors, social scientists, the Data-Base seeks specifically to include master artisans and other technically-skilled persons with field experience who are usually left out in other similar exercises.

All those who have the necessary background and motivation, or who may know of others who this appeal may not otherwise reach, are requested to contact: D. Raghunandan, Secretary, Centre for Technology & Development (Society for Economic & Social Studies), B-1, Second Floor, Local Shopping Centre, J-Block, Saket, New Delhi-110017. □

BOOK REVIEWS

"Metal-Ions in Biological Systems" ; (Ed.) H. Sigel, Marcel Dekker, Inc., New York : Vol. 22 (1987), pp. xxiii+290 ; Vol. 23 (1988), pp. xxix+488 ; Vol. 24 (1988), pp. xxix+424.

While the total metal content of a healthy adult man is only ca. 3% of the body weight, life depends much more upon them than what may appear from this figure alone, and this is true even for some of these metals present at ultra-trace amounts. Information regarding the vital role of such trace metals in biological systems have accumulated practically during the last 40 years. The monumental series "Metal-Ions in Biological Systems", edited by Professor Helmut Sigel of the Institute of Inorganic Chemistry, University of Basel, Switzerland, is a well documented source book of all valuable up-to-date information in the subject and is really indispensable to teachers, students and research workers interested in and engaged in the field of what is now aptly known as Bio-inorganic Chemistry.

Volume 22 of this series contains information on the application of some very useful physical methods such as ENDOR, EPR and ESE techniques based on paramagnetic species and their enormous potential and utility in probing the coordination environment of metal ions in biological systems, such as metalloproteins, metal-nucleotide complexes, etc., structure elucidation and determination of stability constants even in very complicated systems with the species present at low concentrations. All recent advances in the field are summarized in this volume. The contents of this volume is thus a logical extension of the NMR technique which has been covered widely in vol. 21 of this series.

Volume 23 deals with nickel and its role in biological systems. Despite the fact that the abundance of nickel in the lithosphere and hydrosphere is comparable to that of many of the other transition metals of well-established biological role known from somewhat eariler days, it is not until the seventies of this century that definite biological functions of nickel became known and its essentiality in biological systems demonstrated. The various aspects covered in this volume are on the geochemistry of nickel and its presence in natural environment --lithosphere, hydrosphere, etc.; accumulation of nickel in aquatic plants and animals ; metabolism of nickel ; binding of nickel to simple biological ligands like citrate, amino-acids, peptides, etc.; nickel in metalloproteins and enzymes such as urease, hydrogenases, etc.; nickel binding to nucleosides and nucleotides; nickel-DNA interaction and role of nickel in carcinogenesis, nickel toxicity ; and lastly analysis of nickel in biological materials where nickel is present at very low concentrations and as such special techniques are needed for reliable data. Various photometric, spectroscopic and electrometric methods which are suitable for the purpose are discussed.

In volume 24 the role of aluminum in biology is well covered. For a long time this most abundant metal of the lithosphere was considered to be neither essential nor harmful to life. However, association of this metal with brain disorders is now well recognized and hence studies on aluminum and its role in biology are gaining importance. In fact, accumulation of Al^{3+} in acidic natural waters due to acid rains has cause dgreater concern about this metal. In this volume the topics widely covered are bio-inorganic chemistry of aluminum; presence of aluminum in natural environment; physiology of aluminum phytotoxicity and tolerance ; aluminum in the diet and factors affecting retention of aluminum; toxic effects of aluminum; its clinical recognition and management; possible role of aluminum in degenerative diseases of the brain and nervous system, renal failure, etc.; and lastly on the analysis of aluminum in biological materials by special techniques for reliable data, viz. atomic absorption and emission spectroscopic methods, neutron activation analysis, etc. There are some misprints in pages 35 and 37 of this volume which should be noted by the users from the "Errata" provided by the publisher in a separate printed sheet. ☐

D. Banerjea

Biography and Scientific contributions of Professor M. L. Roonwal, Zoologist, Entomologist and Educationist. 80th Birthday Souvenir Volume Edited by R. C. Sharma, Zoological Survey of India. Published jointly by the Entomological Society of India, the Zoological Survey of India and Department of Zoology, University of Jodhpur, Jodhpur, 1988.

The Souvenir volume commemorating the 80th birthday of Professor M. L. Roonwal, containing biographical Sketch and Scientific contributions.

The book contains a list of more than four hundred publications, indicative of Professor's sustained scientific endeavour of nearly six decades. In addition to the above, critical reviews of Professor Roonwal's work has also been incorporated.

Though Professor Roonwal's principal field of interest is entomology, he has devoted considerable time on ecology and systematics of birds and mammals. He has also extensive publication on the population biology, population and population density of locusts and has spent nearly 35 years in studying ecology, morphology, taxonomy and control of termites.

The book edited by Shree Sharma, containing exhaustive and informative list of publications of Professor Roonwal, will definitely be very useful to researchers in the field of Zoology and Entomolgy. ☐

Asok Ghosh

Letters to the editor

Fruit quality attributes of some polyembryonic varieties of mango

A number of polyembryonic varieties have been recorded in mango[1] and possibilities of their use as rootstock for commercial mango varieties have been explored in Florida and Israel[2]. Among them some of the varieties are early, regular, prolific bearers and thought to be the best because of good fruit qualities. To date, there are no data available on the area involved in the cultivation of these varieties and little attention has been given to their fruit quality. The present study was conducted to find out the fruit-quality attributes of different polyembryonic mangoes.

The plants of fourteen varieties of polyembryonic mango, viz. Bappakai, Nakare, Chandrakaran, Kurukan, Peach, Olour, Muvandan, Kesington, Mylepellian, Vellaikulamban, Prior Starch, EC-95862 and Kitchner, introduced at the Indian Institute of Horticultural Research, during 1978-79 from different sources have been fruiting for the last five years. Twenty-five fruits from each variety (when fruits are fully ripened) were taken for chemical analysis. The chemical analysis of fruits in respect of TSS, acidity, reducing sugar, non-reducing sugar, ascorbic acid and carotenoids was done as given by Ranganna[3].

The data presented in Table 1 showed significant difference between varieties in fruit-

TABLE 1 : Polyembryonic mango varieties fruit quality attributes

Varieties	TSS (°Brix)	Acidity (%)	Reducing sugars (%)	Non-reducing sugars (%)	Ascorbic acid mg/100 g pulp	Total carotenoid mg/100 g
Bappakai	13.00	0.29	4.44	6.88	125.0	3.26
Nakare	13.50	0.32	3.59	7.93	150.0	2.00
Chandrakaran	25.25	0.26	3.18	14.27	75.3	2.51
Karukan	16.25	0.26	3.26	13.04	225.0	2.20
Peach	13.0	0.06	3.28	9.21	75.0	2.57
Olour	14.0	0.32	4.50	6.61	235.0	1.80
Muvandan	13.0	0.26	3.10	5.47	50.0	3.82
Kensington	16.75	0.13	3.62	12.57	185.0	3.86
Mylepellian	19.0	0.16	3.10	14.59	62.50	3.71
Vellaikulamban	19.50	0.13	3.44	8.32	75.0	2.65
Prior	15.00	0.17	3.10	6.42	125.0	2.06
Starch	20.40	0.32	3.13	12.97	175.0	2.20
EC-95862	15.40	0.13	3.10	11.13	225.0	1.95
Kitchner	13.20	0.06	3.17	10.13	175.0	2.00
F. test	**	**	**	**	**	**
S. Em	0.15	0.007	0.02	0.14	2.39	0.006
C. D. at 5%	0.47	0.02	0.09	0.63	8.31	0.025

quality attributes. TSS was found to differ significantly between or within investigated varieties. Chandrakaran produced highest (25.25° Brix) followed by Starch, Vellaikulamban and Mylepelian whereas Bappakai and Muvandan (13.0° Brix) recorded lowest TSS. Acidity of fruits showed significant differences between varieties and ranged 0.06% in Peach to 0.32% in Nakare and Olour. Reducing sugar was found to be maximum in Olour followed by Bappakai. Muvandan, Mylepelian, Prior and EC-95862 fall in lowest category. As regards non-reducing sugars, Mylepellian and Chandrakaran had maximum and Muvandan had less non-reducing sugars. Ascorbic acid was maximum in Olour and minimum in Muvandan. Significant difference were recorded in total caroteroids among the varieties. Kensington produced the highest total carotenoids followed by Mylepelian and Peach. Minimum total carotenoids was recorded in Olour.

Thus, it is evident that the polyembryonic mango varieties differed significantly in respect of various fruit quality attributes such as TSS, acidity, reducing sugars, non-reducing sugars, ascorbic acid and total carotenoids. These difference are supposed to be due to different genetical make-up of the variety and also because of the difference in their fruit development period and the ripening season. Ganguly *et al.*[4] and Pandey[5] had also reported difference in the chemical composition of few polyembryonic mango varieties.

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Received : 7 November, 1988.
Revised : 13 February, 1989.

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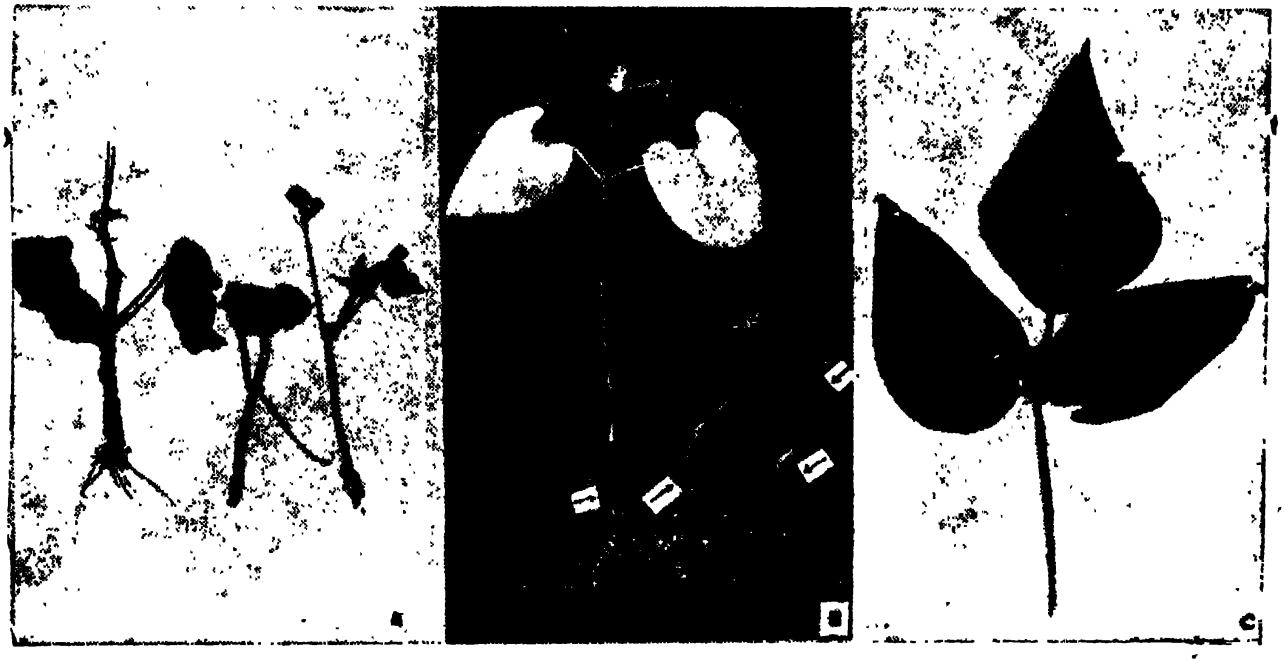
Collar rot, leaf and pod blight of bean caused by seed-borne *Drechslera tetramera*—A new alarming disease of Kumaun hills of U. P., India

Bean (*Phaseolus valgaris* L.) is one of the important vegetable cash crops of Kumaun Hills. During the course of study of the fungi associated with seeds, seedlings, leaves and pods of bean, *Drechslera tetramera* was found a serious disease casual agent. Seeds, seedlings, leaves and pods from 6 different sites of Kumaun were collected under aseptic conditions and their mycoflora were detected by standard pathological techniques (ISTA[2]). Infected seeds by *D. tetramera* were small, slightly shrivelled with greenish black discolouration at germinating end. In blotter and agar plate method of seed health testing severe seed rot and seedling mortality by root and hypocotyl rot and blight of cotyledonary leaves were observed. Affected parts were covered by fungal conidia. Seed infection ranged from 0.5% to 15% in different sites.

Infected seedlings, leaves and pods collected from fields of different sites were washed by running tap water for 10 minutes, treated by NaOCl solution (1% available chlorine), washed by sterilized water and dried in sterilized blotters to check the contamination by bacterial colonies. Infected parts were inoculated for 7 days in agar (Potato dextrose agar) plates and observed for the growth of *D. tetramera.* Under field conditions it caused 15 to 25% infaction of seedlings, which showed water-soaked, grey brown lesions at collar and hypocotyl region in rainy months of July-August. High infection under field conditions indicates that the pathogen inoculum increased in soil by naturally infected seeds and infected more seedling in comparison of seed infection. Such seedlings gradually developed both wilting and blighting, and yellowing (Plate 1, Fig. A) of aerial parts and collapsed due to enormous collar rot (Plate 1, Fig. B). Disease intensity was severe up to one month of sowing.

In later stages under field conditions, *D. tetramera* induced minute, angular to circular, slightly sunken, brown to black, necrotic spots on leaves containing fungal mycelial and conidial mass. Such spots coalesced to form a bigger ones surrounded by chlorotic areas (Plate 1, Fig. C). Infection started from lower leaves near soil surface to upwards. Infected leaves and tender twigs dropped-off early.

Pods of bean infected by *D. tetramera* were small in size, shrivelled, with dark brown, angular, sunken lesions; under moist weather covered by greenish black conidial and mycelial mass of pathogen. Such pods yielded heavily contaminated and infected seeds that act as transmitting agent of the pathogen in next crop generation. Moderate temperature



Plate—1

Fig. A : Bean seedlings infected by *Drechslera tetramera* showing root and hypocotyl rot, wilting and blighting.

Fig. B : Seedlings of bean showing collar and root rot, yellowing and blighting of aerial parts due to infection of *D. tetramera.*

Fig. C : Bean leaves showing angular and circular, slightly sunken necrotic spots of *D. tetramera.*

(from 25 to 30°C) and heavy moisture (RH 90-95%) in rainy season highly favoured the disease incidence.

Location of fungal pathogen in different seed parts was determined by adopting the method of Mathur *et al.*[4] The study showed that commonly this pathogen invaded seed coat tissues followed by cotyledons. Embryo infection was found only in few seeds.

Pathogenicity test of the isolate was conducted under green house conditions (Temperature 20 to 30°C, Air moisture 30%) in sterilized peat soil adopting the method of Singh and Mathur[1] by spreading 8 days old inoculum from Potato Dextrose Agar medium around the collar region of week old seedlings. The pathogen resulted 50% seedling loss through wilting of serial parts which appeared within a week of inoculation and lead to yellowing, wilting and later on collapse of seedlings from rotting at the collar region within next week. The rest of the plants later on developed leaf and pod blight symptoms which were indentical to those observed under field conditions. In later stages of plant growth the pathogen caused 20 to 25% infection of leaves and pods of surviving seedlings.

The fungus was identified with the help of monograph of Chidambaram *et al.*[3] as *Drechslera tetramera* (Mc Kinney) Subram. & Jain.

This disease seems to be one of the serious seed-borne disease of bean, affecting Contender, Black queen, Master piece, Holland-500 and other cultivars growing in this hilly region. The field observations and laboratory test clearly reveal it's destructive and pathogenic nature. This is the first record of a serious disease of bean crop from India, caused by *D. tetramera*.

Financial assistance from I.C.A.R., New Delhi and informative literature from Director, Danish Government Institute of Seed Pathology, Copenhagen, Denmark is gratefully acknowledged.

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Received. 7 November, 1988.

Revised: 9 March, 1989.

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A tetrafoliate mutant in *Vigna mungo*

Black gram [*Vigna mungo* (L.) Hepper] is one of the important grain-legumes of the Indian sub-continents. Due to the high protein content[1], it is mainly cultivated for human consumption. Moreover, it is adaptable to a wide range of agro-climatic conditions and can be grown both in *kharif* and *rabi* seasons. However, the yield potential of this crop is very low and is susceptible to a number of diseases and insect pests. Therefore, attempts are being made to improve it through mutation breeding methods. This communication deals with an interesting leaf mutant in black gram as induced by Sodium azide (NaN_3)—a powerful and efficient mutagen[2].

Seeds of T-9, a widely cultivated variety of black gram, were procured from G.B.P.U.A. &

T., Pantnagar. After having determined the LD_{50} dose[3], seeds were treated with 0.01, 0.02, 0.03 and 0.04% aqueous solutions of NaN_3 for 6 hr at 27±2°C. M_1 generation was raised in a randomized complete-block design with three replications. In the M_2 generation, the mutation rate (number of mutants per 100 M_1 plant) for the variation in leaflet number was 8.66%. A mutant with tetrafoliate instead of the normal trifoliate leaves was isolated from the population treated with 0.03% NaN_3. It is interesting to note that in contrast to the usual first pair of leaf in control (Fig. 1), the mutant gave out three first leaves (Fig. 2). The overall growth performance of the mutant is better than its parent, however, the seed yield per plant has been found to be poor (Table 1). Moreover, it flowered and matured 15-20 days later than

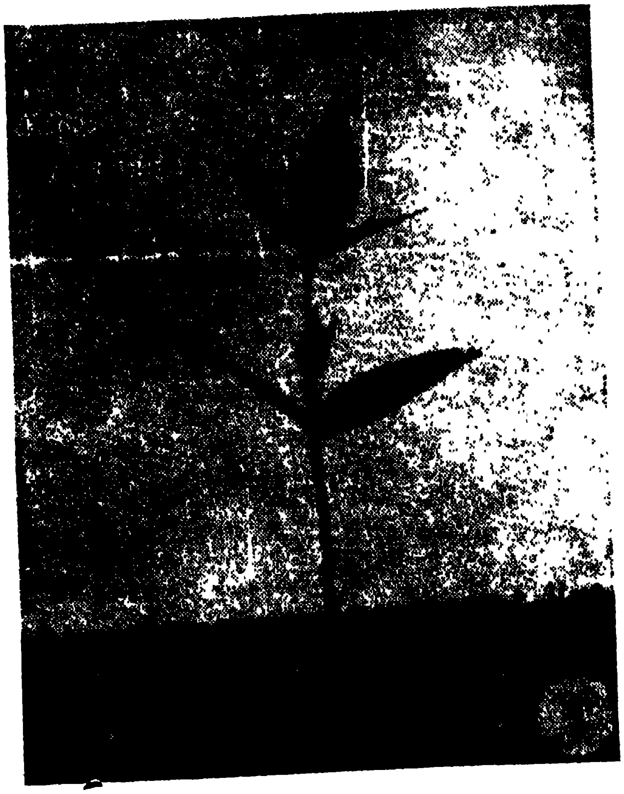

Fig. 1. Control with usual first pair of leaf and trifoliate leaf.

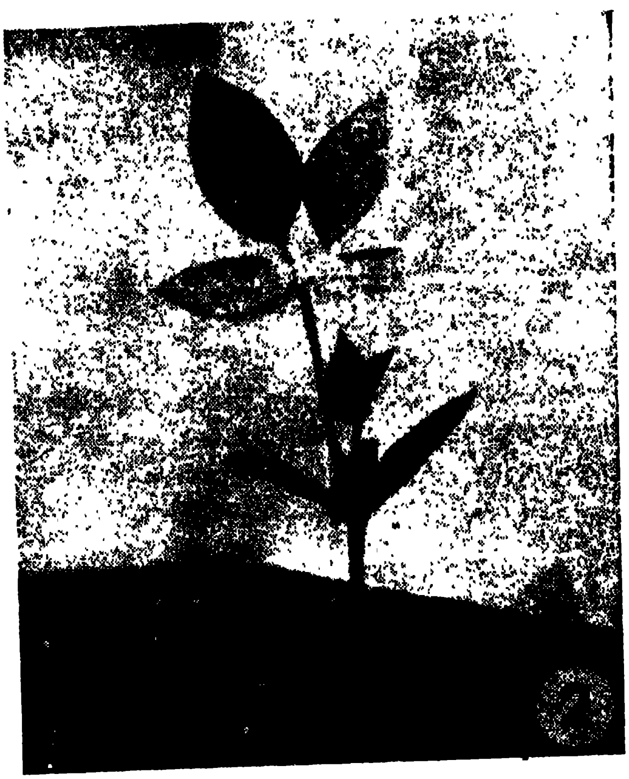

Fig. 2. Mutant with three first leaf and tetrafoliate leaf.

TABLE 1 : Mean values of different agronomic characters of the tetrafoliate mutant and its parent

Parameter	Parent	Mutant
Plant height (cm)	33.5 ±0.68	42.8±0 95*
Nodes/plant	12.9 ±0.73	17.3±0.63*
Branches/plant	3.7 ±0.36	6.4+0.37*
Leaves/plant	17.4 ±0.74	31.6±0.42*
Days to flower	45.7 ±0.96	58.9±1.02*
Clusters/plant	12.3 +0.59	8.1±0.52*
Pods/plant	36.8 ±0.94	25.4±0.70*
Pod length (cm)	4.1 ±0.17	3.6±0.10*
Seeds/pod	5.2 ±0.46	4.6±0.33
100-seed weight (gm)	3.58±0.17	3.44±0.10
Total plant yield (gm)	6.95±0.27	4.25±0.10*
Days to mature	89.5±0.85	104 2±1.33*

*Significant at 1% level.

its parent (Table 1), the mean time of flowering being more or less the same (34.3 days in mutant and 32.8 days in parent). Cytological behaviour of the mutant is normal with 11 bivalents at Metaphase I of meiosis and the pollen fertility (stainability of pollen grains in 1.0% acetocarmine) is 95.62%, almost equivalent to the parent (96.12%).

Mutants with increased number of leaflets have been reported in black gram[4]. The character has been found to be governed by a single recessive gene[5]. The recorded mutant may, therefore, be attributed to the mutation of gene governing leaflet number in black gram.

Due to the improved growth performance, the mutant may be exploited for green manuring and feeding the cattles. The poor yield performance and late flowering and maturing habit may be rectified by including the mutant in cross-breeding programme with other high yielding and early maturing genotypes.

The authors are grateful to Prof. K. S. Bilgrami, Head of the University Department of Botany, Bhagalpur University, Bhagalpur for providing the research facilities and encouragements. One of us (Khan) is also thankful to the CSIR, New Delhi for financial assistance in the form of a Senior Research Fellowship.

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Received : 10 November, 1988.
Revised : 17 January, 1989.

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Occurrence of sooty mould on the noxious weed *Lantana camara* in Western ghats : its evaluation as a biocontrol agent

As an important forest-weed in India, *Lantana camara* L. (Verbenaceae) impeds natural and artificial regeneration of forests[1,2]. It is also an important source of fire hazard in deciduous forests[3]. In the course of our field visits to Anaimalai hills during June-November 1987, *Lantana* bushes were observed to be heavily covered by a sooty mould caused by *Capnodium* sp. Sooty moulds are generally injurious to the plants as they hinder assimilation and obstruct the respiration of the leaves[4].

The colonies of *Capnodium* sp. were foliicolous, caulicolous, amphigenous but mostly epiphyllous, black, carbonaceous, velvety, covering the entire plant-parts associated with insects. Mycelia were brown, irregularly branched, loosely to closely reticulate and the cells gave beaded appearance, 12-22 × 3-5 μm. Pycnidia were black, simple to branched, bulged just above the base, tapering towards the apex and striated, up to 200 μm long; up to 14.5 μm broad at the base, up to 28.5 μm broad at the bulged portion and up to 14 μm at the apex. Pycnidiospores were not seen.

TABLE 1 : Incidence of coccids on *Lantana* and the relative intensity* of the sooty mould on the upper surface of randomly selected leaves from the infested bushes over varying altitudes as observed in the first week of September, 1987

	Bushes in the open			Bushes under shade		
Altitude (Meter)	Coccid infested (%)	Sooty mould** intensity	Completely@ defoliated (%)	Coccid infested (%)	Sooty mould intensity	Completely defoliated (%)
350	0.00	0.00	0.00	0.00	0.00	0.00
750	6.25	1.4 ± 1.3	0.00	16.67	2.0 ± 1.7	0.00
800	39.39	3.2 ± 0.9	6.06	73.33	2.2 ± 1.6	11.11
930	87.50	3.5 ± 1.6	2.08	97.37	2.8 ± 1.5	47.37
980	83.33	4.3 ± 1.0	0.00	81.25	1.7 ± 1.3	18.75
1040	40.00	1.5 ± 0.8	0.00	13.33	0.8 ± 0.5	0.00
1440	54.55	1.4 ± 1.1	0.00	12.50	0.8 ± 0.7	0.00

*Graded 0-5 where, 0 denotes no sooty mould while 5 indicates 100% sooty cover.

**Each figure is the mean grade of 500 leaves + Standard Deviation.

@Completely defoliated due to heavy coccid infestation and subsequent sooty mould development. The healthy bushes remained unaffected.

The development of the sooty mould was always preceded by the infastation of the *Lantana* bushes by the scale insect, *Orthezia insignis* Browne (Coccoidea : Ortheziidae). The nymphal stages of the coccid were restricted to the ventral side of the leaves, mostly along the midrib. The adults were frequently found on the twings and shoots and migrated to the newer leaves when formed.

The incidence of coccid infestation and sooty mould was observed over an altitude range of 750-1,440 m M.S.L. (Table 1). However, intense attack was noticed around 800-980 m M.S.L. The potential of *Capnodium* sp., in combination with the coccids, in controlling *Lantana* is promising as it resulted in complete defoliation in a number of bushes. Generally, the bushes growing under shades were severely affected probably due to their poor nutritional status caused by the total curtailment of photosynthesis by the sooty cover.

The authors are grateful to Prof. R. Jayarajan, Head, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore for critical perusal of the manuscript.

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Notes on the occurrence and distribution of *Glossostigma diandrum* (Scrophulariaceae) and *Richardia scabra* (Rubiaceae)

During botanical excursions, two species of plants—*Glossostigma diandrum* (Scrophulariaceae) and *Richardia scabra* (Rubiaceae) –were collected from Simlapal Block of Bankura District and Haripal Block of Hooghly District, West Bengal respectively. The perusal of available literature reveals that very little or no information[1-15] exists on floristics of these two plants. During the field work in the above places, several attempts were made to study certain aspects of phenology and ecology of these plants.

For security of the earlier records of these plants, the available herbarium sheets lodged in the CAL Herbarium were consulted. It was found that in case of *Glossostigma diandrum*, the herbarium sheets (CNH Nos. 00036, 06060, 01039, 04484, 06574 and 60235, dt. 28.11.1964, 28.10.1967, 10.11.1973, 4.10.1977, 25.9.1978 and 16.2.1979 respectively) were prepared out of specimens collected from Bihar, Deccan Peninsula, Orissa, Rajasthan, Upper Gangetic Plains, etc. but not from West Bengal at all. The occurrence of *Richardia scabra* was documented by the collections deposited in the Central National Herbarium (CNH Nos. 00819, 39014, 11785, 60694, 62697 and 11615 dt. 25.9.1961, 21.6.1964, 16.6.1977, 14.3.1979, 21.6.1979 and 30.8.1982 respectively) from Assam, Bihar, Deccan Peninsula, Meghalaya and West Bengal[16].

In view of the above, the authors felt it desirable to record some relevant information on the occurrence and distribution of these plants observed in course of this investigation. The present study on these two plants offer some additional herbarium sheets of the specimens collected from the above two places. These sheets are deposited in the CAL and CUH herbaria.

Diagnoses of Plants

Glossostigma diandrum (Linn.) Kuntze, Rev. Gen. Pl. 2 : 461.1891.

[Syn. *Limosela diandra* Linn.; *Microcarpaea spathulata* Hook., *Glossostigma spathulatum* (Hook.) Wight & Arn. ex Arn.] (Fig. 1).

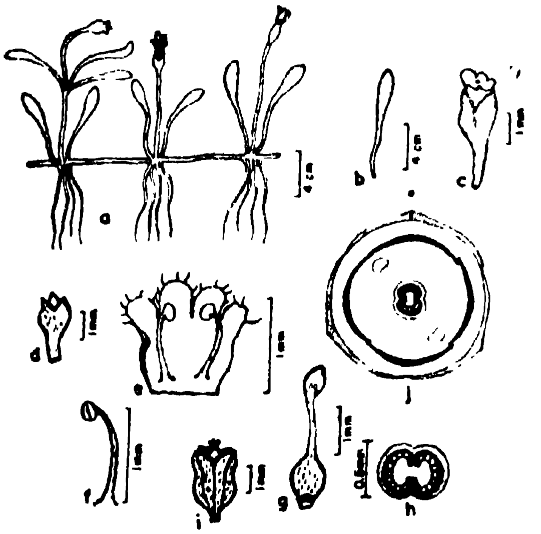

Fig. 1. *Glossostigma diandrum* (Linn.) Kuntze : a. Habit, b. Leaf, c. Flower, d. Calyx e. Corolla split open, f. Stamen, g. Pistil, h. T. S. of ovary, i. Fruit, j. Floral diagram.

Minute, tufted, creeping, weak and marsh annual herb. Leaves radical, linear-spathulate, succulent. Flowers axillary, solitary, pinkish white. Fruit globose capsule.

Flowering and Fruiting : January-February.

Distribution : Throughout India, Sri Lanka, Tropical Africa and Australia.

Specimens examined : Simlapal, Bankura (West Bengal), Chattopadhyay 790.

Richardia scabra Linn. Sp. Pl. 330. 1753 [Syn. *R. brasiliensis* Gomez; *R. pilosa* Ruiz and Pavon; *Richardsonia pilasa* (Ruiz and Pavon) H.B.K.] (Fig. 2).

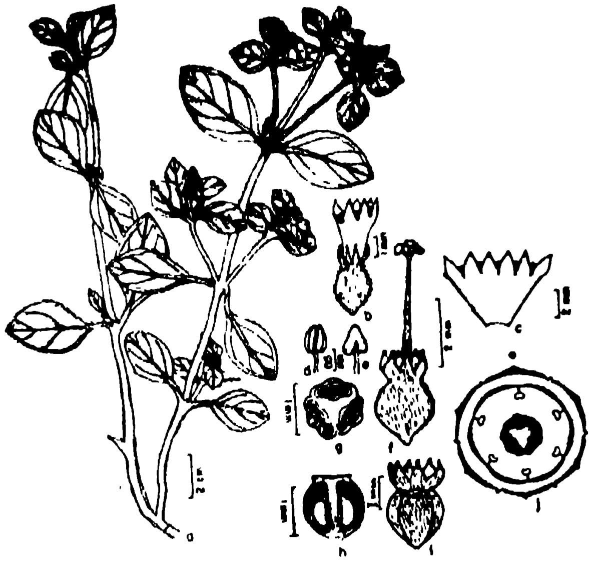

Fig. 2. *Richardia scabra* Linn.: a. A twig, b. Flower, c. Corolla split open, d & e. Stamens, f. Pistil, g. T.S. of ovary, h. L. S. of the same, i. Fruit, j. Floral diagram.

Procumbent, densely hispid, annual herb. Leaves ovate or elliptic-lanceolate, scabrous. Flowers 3-merous, white, borne in terminal capitate clusters, subtended by 2 pairs of involucral leaves. Fruit subglobose, 3-celled capsule, crowned by persistent calyx.

Flowering and Fruiting : July-November.

Distribution : Native of tropical America; also distributed in tropical Africa, India and Hawaii.

Specimens examined : Chandanpur, Haripal (West Bengal), Chattopadhyay 726.

A thorough observations of available literature and the herbarium sheets lodged in the Central National Herbarium (CAL), Calcutta and the Industrial Section of Indian Museum, Calcutta reveal that the plant *Glossotigma diandrum* (Scrophulariaceae) chiefly occurs in Bihar, Deccan Peninsula, Orissa, Upper Gangetic Plains and Rajasthan. From a brief history of its occurrence in India, it seems that the plant was mentioned by J. D. Hooker[7] which was collected from Bihar and later by D. Prain[6] from the same State and by T. Cooke[10] from Bombay.

The plant is found to grow on the banks of ponds, tanks, and other water sources from where water recedes by January. It appears first on the moist sandy-clayey or muddy substratum as a pioneer plant and grows profusely within a short peroid forming a dense association. The plant bears stolons which interoven in the mud and leafy branches come up from the nodes. The plant is small in size (up to 2 cm long) and succulent in texture. It has a life-span of less than one month during which it completes its flowering and fruiting. As such, the plant often escapes notice and is missed in the field and is, therefore, mistaken as rare due to lack of collection[14].

Richardia scabra Linn. (Rubiaceae) is the only introduced species in India. The perusal of literature reveals that the genus *Richardia* Linn. with 10 species is a small genus of herbs native to tropical and sub-tropical America and distributed to tropical Africa and Hawaii. It extends up to the warmer temperate regions of the United States. It inhabits Savannahs and grasslands in sandy soil from high tropical mountains to sea level, often as a waif. This distribution includes United States, Mexico, Central America, West Indies and South America. It is not as yet a pan-tropic weed for it has not been found in the West Indies beyond Cuba and Jamaica nor east of Guyana in South America. Outside of the New World, it is known only from Eastern and Southern Africa[15].

In India, *R. scabra* Linn. was perhaps introduced after 1881 as the plant was not recorded by Hooker[7]. Prain[6], Duthie[9] and Harines[9] also have not mentioned this species in their respective regional floras. Kanjilal *et al.*[31] reported its occurrence from Shillong (Meghalaya). Subsequently, it was recorded by Srivastava[11] from Bihar, by Balakrishnan[12] from Anantgiri of Andhra Pradesh and Matthew[14] from Carnatic of Tamil Nadu. The species is restricted mostly to the farm areas. This speaks for its exotic nature and shows that it was introduced to the farm probably from seed mixture[11]. However, the exact record of its introduction is not known. After being introduced in India, *R. scabra* Linn. has been almost naturalised in Meghalaya, while in Assam, Bihar and the Deccan Peninsula, its occurrence is moderate to rare.

In Bihar, the species occurs as a weed on the arable land and as a non-weed along road-sides, etc. The population of the plant is more on the uplands than on the low lands, indicating its well-adaptability under low-fertility conditions[11]. In the present reported area, the plant grows in open and uncared situations on clayey soil mixed with gravels. The plant has some characteristic growth forms including prostrate habit, densely hispid long internodes, long branched roots, etc.

From the beginning of March, the germination of the seeds starts and small seedlings emerge slowly and gradully the growth becomes luxurient. Flowering starts from the end of July and continues till the end of November. From the middle of December, the plants start to disappear gradually.

The plant is easily eaten by farm animals. The local people of Bihar use it as fodder for cattle both in the form of green fodder and silage[11]. The maximum yield of hay is about 5,000 kg/hectre. It may also be used for pasturage. The root has diaphoretic and emetic properties. It contains emetine and starch. It is a source of the undulated or farinaceous ipecac used as a substitute or adulterant of true ipecac[1].

The plant has a dominating tendency, as it does not allow the other species to grow in association of it[11]. As such, the plant may be an alarming species if it invades the agricultural lands.

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Effect of 2, 4-dichlorophenoxy acetic acid and maleic hydrazide on growth of blue-green algae (cyanobacteria) *Anabaena doliolum* and *Anacystis nidulans*

Cyanobacteria (commonly known as blue-green algae) occupy an important position among the soil and water microflora. The role of nitrogen-fixing cyanobacteria in the nitrogen economy of rice agriculture is now widely appreciated and in rice field they constitute a dominant microflora[1-2]. Since nitrogen-fixing cyanobacteria constitute an invariable component of rice fields and also are found growing in polluted or contaminated environment, they shou'd be thoroughly screened for any deleterious effect of commonly used herbicides. Although herbicides are normally used to control the growth of weeds in agricultural fields, a major portion is usually deposited on the surface of the soil and might adversely affect the other existing microorganisms including cyanobacteria. Chemicals such as 2, 4-dichlorophenoxy acetic acid (2, 4-D) and maleic hydrazide (MH) are frequently used as herbicides in agriculture and forestry other than in the rice fields. The recommended level of 2, 4-D for weed control in the field has been reported to inhibit growth and nitrogen fixation of various cyanobacteria[3-6]. The present investigation was, therefore, undertaken to investigate the influence of 2, 4-D and MH on the growth of two cyanobacteria, *A. doliolum* and *A. nidulans*

Anabaena doliolum and *Anacystis nidulans* were insolated from paddy fields of Banaras Hindu University campus and were purified by employing standard microbiological techniques. The cultures were routinely grown in Chu No. 10 medium[7]. For *A. nidulans*, calcium chloride was replaced by calcium nitrate as a nitrogen source. The cultures were incubated in a culture room maintained at a temperature of 25±1°C and illuminated with day-light fluorescent lamps offering an average light intensity of 2,500 Lux on the vessels. Liquid cultures were shaken manually twice a day.

Stock solutions of 2, 4-D and MH were freshly prepared with sterile distilled water and added to the actively growing cultures to get final concentrations ranging from 5 to 25 μM and 0.01 to 100 μM, respectively. Growth was measured in terms of dry weight per litre of the culture. Dry weight of the algal cells was determined by collecting and washing the cells from a known volume of culture by centrifugation and drying to a constant weight in a hot-air oven at 90°C. Weight was measured after cooling the dish in a desiccator for 15 min at room temperature.

TABLE 1 : Effect of 2, 4-D on the growth of *A. doliolum* and *A. nidulans* (growth after 10 days)

2, 4-D(μM)	Dry weight (mg/litre)			
	A. doliolum		*A. nidulans*	
Control (without 2, 4-D)	200.0	(0.0)	300.0	(0.0)
5.0	185.0	(7.5)	275.0	(8.3)
10.0	175.0	(12.5)	270.0	(10.0)
15.0	170.0	(15.0)	265.0	(11.7)
20.0	125.0	(37.5)	254.0	(15.3)
25.0	105.0	(47.5)	225.0	(25.0)

Values in parentheses indicate per cent inhibition in dry weight in relation to control

From Table 1, it is evident that 2, 4-D was inhibitory for the growth of both *A. doliolum* and *A. nidulans* at all concentrations tested. The inhibition was more pronounced in *A. doliolum* than in *A. niaulans.* The inhibition of growth may be explained on the basis of the two-point attachment theory of auxin action in terms of a clogging of the 'growth enzymes', by excess substrates (2, 4-D), or the inhibition may be due to the production of the volatile inhibitor ethylene[8]. 2, 4-D at higher concentrations led to toxicity and lysis of the cells. Since 2, 4-D was found to be inhibitory for the growth of these algae, it may be used for algal control also.

MH has been shown to inhibit the growth and cell-division of a number of lower and higher plants[8-9]. A consistent reduction in the dry weight of both the algae was observed with increasing concentrations of MH from 0.01 to 100 μM (Table 2). However, MH was found to be less inhibitory in comparison to 2, 4-D. But a concentration of MH, 100 μM or above would prove more inhibitory for the growth of *A. doliolum* and *A. nidulans*. As reported in other eukaryotic organisms, MH may influence growth by inhibiting protein synthesis through its involvement with nucleic acids. From our data, it may be concluded that 2, 4-D and MH can be used as efficient herbicides for controlling growth of various blue-green algae in ponds, lakes and in areas other than agricultural fields.

TABLE 2 : Effect of MH on the growth of *A. doliolum* and *A. nidulans* (growth after 10 days)

MH (μM)	Dry weight (mg/litre)			
	A. doliolum		*A. nidulans*	
Control (without MH)	200.0	(0.0)	300.0	(0.0)
0.01	198.0	(1.0)	295.0	(1.7)
0.10	196.0	(2.0)	293.5	(2.2)
1.00	180.5	(8.3)	292.8	(2.5)
10.00	180.0	(10.0)	289.3	(3.6)
100.00	173.8	(13.1)	285.5	(4.7)

Values in parentheses indicate per cent inhibition in dry weight in relation to control

We are thankful to the Head and Programme Coordinator, Department of Botany for laboratory facilities. One of us (JBS) thanks to CSIR, New Delhi for awarding Senior Research Fellowship.

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Crop response to moisture stress

The crops and varieties that are grown in rainfed/dryland areas are not found promising in moisture use efficiency[1]. Moreover, the traditional cultivars are characterised by longer duration, tall plant stature, low-fertilizer response, photosensitivity, etc. Since the cultivars are of longer duration than the moisture available period, the same face moisture stress, as a result of which low yields are obtained. Keeping the above points in view, field experiments were conducted at the Dryland Agriculture Research Centre, Bhubaneswar (Orissa) to identify efficient crops and varieties having tolerance to moisture stress so that high and stable yields are realised from rainfed upland areas. Three important crops namely rice (*Oryza sativa* L.), groundnut (*Arachis hypogaea* L.) and pigeonpea (*Cajanus cajan* (L.) Millsp.) were chosen for the present study. In each crop, replicated varietal screening trials were conducted in upland situations strictly under rainfed conditions over a number of years. The performance of the varieties in respect of grain yield under normal year (optimum condition) and drought year (stress condition) is reported in this article.

The rainfall during kharif season of 1985 was normal in respect of its distribution pattern and quantity. The crop yields relating to that year were considered optimum. The rainfall pattern was erratic in 1986 with a continuous drought spell of 16 days (23 August to 7 September). The long dry period caused severe moisture stress to the standing crops resulting in prolongation of maturity period and reduction of grain yield in each crop. There was considerable prolongation of maturity period in rice and pigeonpea but not in groundnut crop. In rice the maturity period of all the cultivars was extended varying from 2 to 27 days due to severe moisture stress and in pigeonpea it ranged between 4-12 days (Table 1).

Both moisture stress and prolonged maturity period reduced the grain yields in rice and pigeonpea to a great extent. In rice the reduction of grain yields varied from 10 to 91% (Table 1). The yield reduction was very high in the cultivars where the maturity period was extended beyond 10 days due to moisture stress. There was significant and positive correlation ($r = 0.727$) between maturity prolongation and yield reduction due to moisture stress. The results of varietal screening revealed that rice cultivars like DR 83-1, DR 83-2, DR 92, IET 7261, IET 7625, IET 7633, IET 7614 and IET 7911 had good tolerance to moisture stress. The other entries were poor yielders and of long duration as compared to the standard. The yield performance of DR 83-1, DR 83-2 and DR 92 in both normal and drought years was superior to other cultivars thereby indicating their stress tolerance capacity[2]. In case of pigeonpea the yield reductions

TABLE 1 : Response of Rice, Groundnut and Pigeonpea cultivars to moisture stress at Bhubaneswar (Orissa)

Crop	No. of cultivars tested	Yield range in normal year (q/ha)	Yield range in drought year (q/ha)	Yield reduction (%)	Maturity prolongation (days)	Promising cultivars having stress tolerance capacity
Rice	20	7.00-27.61	2.00-14.99	10-91	2-27	DR 83-1, DR 83-2, DR 92, IET 7261, IET 7625, IET 7633, IET 7614, IET 7911
Groundnut	16	2.58-11.94	3.94-10.78	7-21	—	JL 24, Robourt 33-1, Kissan, TCG 1704
Pigeonpea	15	2.77-11.22	2.83- 9.61	14-48	4-12	DAS 83-1, DAS 83-2, DAS 83-3, ICPL 87, ICPL 227, ICPL 265

ranged betweet 14 and 48%. The early maturing cultivars were most affected by stress condition as compared to the medium ones. As evidenced from the results, the pigeonpea cultivars, DAS 83-1, DAS 83-2, DAS 83-3, ICPL 227, ICPL 265 and ICPL 87 had shown high tolerance to moisture stress. In consideration of grain yields of both normal and drought years, the superiority of DAS 83-3 and DAS 83-1 was observed. Under drought situation groundnut crop had shown remarkable performance in respect of growth and yield. The crop canopy covered the ground surface very well thereby alleviating the severity of moisture stress. The long dry spell affected grain yields to some extent varying from 7 to 21% (Table 1). The cultivars, JL 24, Robourt 33-1, Kissan and TCG 1704 had shown high tolerance to stress situation. The yield performance of JL 24, Kissan and Robourt 33-1 in both normal and drought years was superior to other entries indicating their high tolerance to stress situation.

On the basis of moisture stress capacity, yield potentiality and profitability, groundnut and pigeonpea are considered more stable and remunerative than rice crop in the rainfed upland conditions in Orissa.

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Self-incompatibility in gladiolus

During seed set studies conducted with ten varieties of gladiolus, it was observed that two varieties namely Psittacinus Hybrid and Jowagenaar did not set any seed under self-pollination (natural, as well as, artificial). These two, varieties however, were found to be cross-compatible, that was capsule development, even when bud pollination was attempted. The two varieties, which were having different ploidy level i.e. Psittacinus Hybrid (Pentaploid, $2n = 75$) and Jowagenaar (tetraploid, $2n = 60$)[1], were subjected to detailed microscopic studies to understand the cause of self-incompatibility.

The studies indicated no penetration .of pollen tubes in the styler canal in both the varieties following self-pollination. Four distinctive events (Fig. 1) with pollen grain germination observed during microscopic studies were : An individual pollen grain may (i) fail to germinate, without phenotypic evidence of abnormality, (ii) begin germination but produce a very short out growth; (iii) produce a pollen tube that grows in an abnormal manner without penetration, and (iv) produce a pollen tube that—attempts penetration but is restricted immediately thereafter.

Self-incompatibility was first noticed in gladiolus by Rawson (Darwin)[2], who found no seed set in crosses between plants of the same variety. Clarke *et al.*[3] reported that cuticle on the papillae forms the physical barrier to pollen tube penetration in case of self-incompatible pollination. However, Ohri[4] observed that actual inhibition of pollen tube growth occurs inside the style, which means recognition of self-incompatible or compatible pollen take places at the stigma surface and the inhibition in case of incompatible pollen occurs in

Fig. 1. Photograph showing different stages of pollen germination

the style. On the basis of the binucleate pollen[5] and pollen tube inhibition inside the style, a gametophytic system of self-incompatibility (GSI) was suggested. Heslop-Harrison[6], however, suggested a sporophytic self-incompatibility system to be associated with 'dry' type stigma and site of the rejection reaction is on stigma itself in cruciferae. In view of the fact that the mature receptive stigma of gladiolus is 'dry' type[7-9] and the present studies, it is suggested that site of the rejection reaction is the stigma itself.

In view of the above contradicting reports of GSI and SSI, a detail study is called for to ascertain the true nature of the self-incompatibility system operating in these two varieties of gladiolus.

The authors are grateful to Director, IARI, New Delhi for providing the facilities to carry out present investigations and to Dr. T. A. More, of Division of Vegetable Crops, IARI, for his suggestions.

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A bio-assay method for evaluation of mulberry leaf quality for silkworm rearing

Evaluation of mulberry leaf quality based on complete silkworm rearing is laborious and time-consuming. Moulting ratio was used by Takeuchi[1,2] as an index for this purpose. However, this test when conducted irrespective of test breed/hybrid, instars (I & II), rearing conditions, degree of feed cut and time of observations on moulting, resulted in different trends and lacked repeatability of performances. The moulting test was improved at this laboratory, Mysore as a standard technique for evaluation of mulberry leaf quality.

Test must be done in I instar. The physiological status of the insect in the I instar is more ideal than in II instar. During I instar active ingestion and digestion accounts for 60% of the eating period compared to 25% in II instar. During II instar, the robustness of the larvae is also reflective of the rearing conditions —feed quantum and quality and growth—in the I instar. The newly-hatched larvae offer homogeneous population for the test. It is desirable to conduct test with the popular silkworm hybrids in the field. Multivoltine x bivoltine hybrid PM x NB18 and bivoltine x bivoltine hybrid, NB18 x NB7, are ideal under South Indian conditions. Strict maintenance of temperature and humidity (26 ± 1°C and 85 ± 3% RH during eating period and 26 ± 1°C and 70 ± 3% RH during moult) are required during test. Since the test is based on fixed number of feeds, the prolongation of larval period due to low temperature can itself result in variation in moulting ratio. It is desirable to maintain a mass bed of 1000 larvae per replication as per statistical design. The quantum of feed and frequency of feed must be maintained as per standard recommendations for test breed/hybrid. Feed is offered at every 6-hr interval. The quantum offered is 1500, 2250, 3000, 3750, 6250, 6250, 8000, 8750 and 7500 mg for 1-9 feeds in Pm x NB18 (total 47.250 g out of 67.500 g total requirement) and 2500, 3750, 3750, 5000, 7500, 7500, 8125, 8750, 10,000 and 8750 mg for 1-10 feeds in NB18 x NB7, (65.625 g out of 87.5 g total requirement) for 1000 larvae. The feed cut suggested is, thus 30% in the former and 25% in the latter.

Total 9 feeds at 6 hours interval are recommended for moulting test with PM x NB18 hybrid After stopping the feed the larvae should be left undisturbed for 24-hr to prepare for moult. Another 24-hr is given to complete the process of moulting. Thus, though the feeding is stopped after 54-hr of eating period, moulting ratio is recorded after 102-hr from brushing. With test hybridNB18 x NB7, 10 feeds are recommended followed by 24-hr preparatory period and another 24-hr moulting period. Thus, moulting ratio is recorded after 108 hr from brushing. The weight of 100 out of moult larvae can be considered as an added index, if leaf quality under different conditions falls in to a single group, for ranking.

The moulting test, as described above, was evaluated to known differences in mulberry leaf quality due to varieties, maturity, shade and chlorosis. The results (Table 1) were in full agreement with ranking based on complete silkworm rearing.

TABLE 1 : Ranking of mulberry leaf quality based on moulting test (hybrid: PM x NB18).

Conditions	Moulting ratio (%)	Conditions	Moulting ratio (%)
Variety		*Maturity*	
S36	81.8	Tender	78.2
S30	80.8	Medium	46.8
S54	79.5	Coarse	31.7
K2	78.4	*Shade*	
S41	65.6	Shaded	45.2
Local	65.6	Non-shaded	78.2
Jatinuni	62.8	*Chlorosis*	
Assamabola	62.2	Chlorsic	9.2
Sujanpur	58.2	Non-chlorotic	78.2

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Received : 9 December, 1988.

[1] Y. Takeuchi, *Bull. Sericul, Exp, Station*, **16**, 476, 1959.

[2] Y. Takeuchi, *Bull. Sericul. Exp. Station*, **17**, 53, 1961.

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(i) R. B. Walton and H. B. Woodruff, *F. Clin. Inst.*, **82**, 924, 1949.

(ii) W. C. Boyd, Fundamentals of Immunology, 1947, p. 123, (Interscience Publishers Inc., New York).

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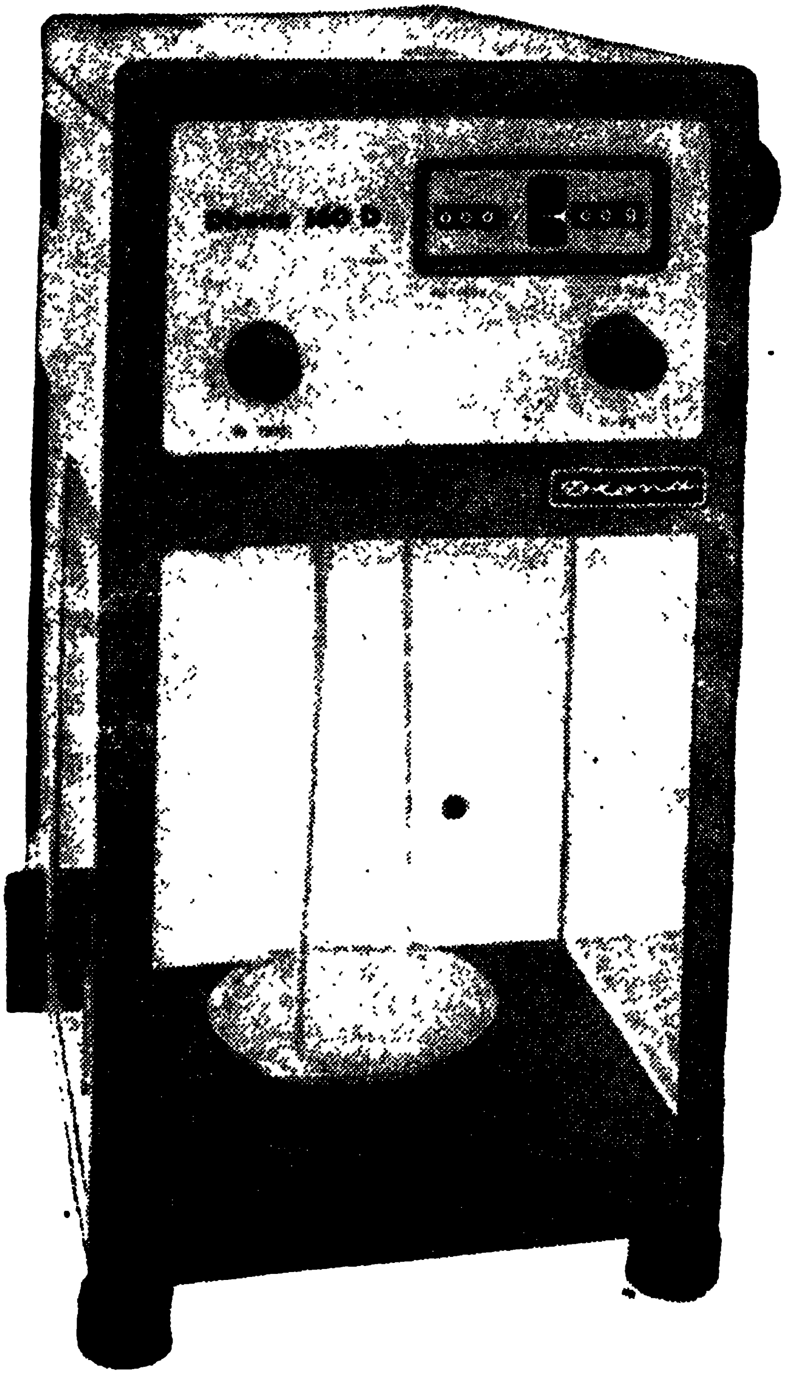

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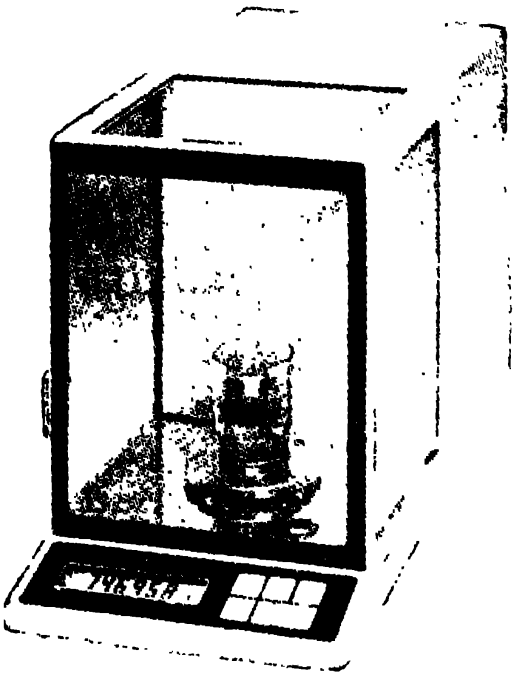

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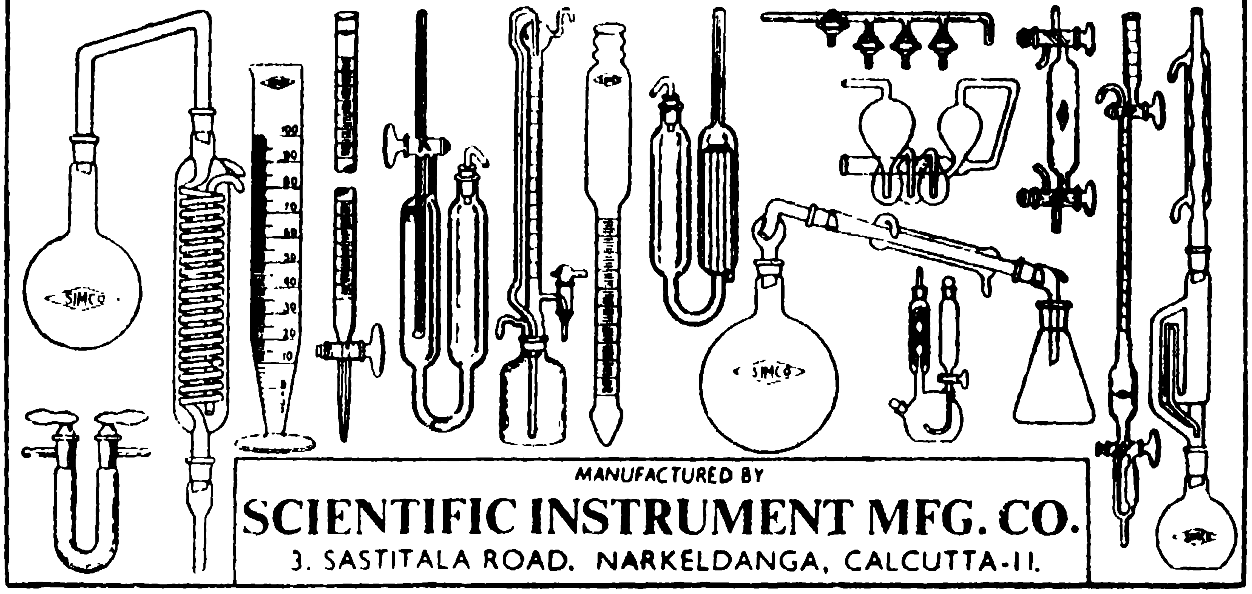

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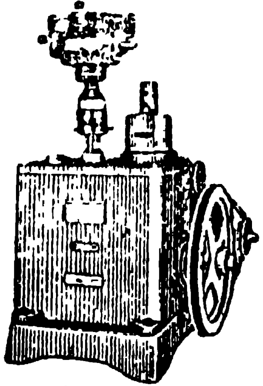

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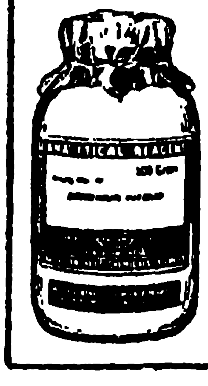

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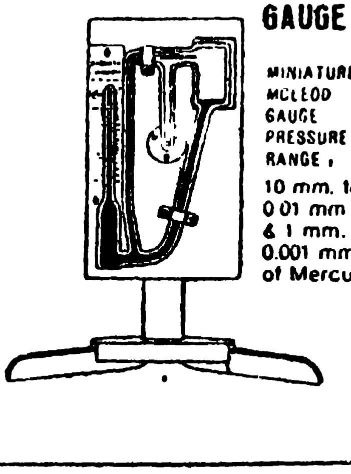

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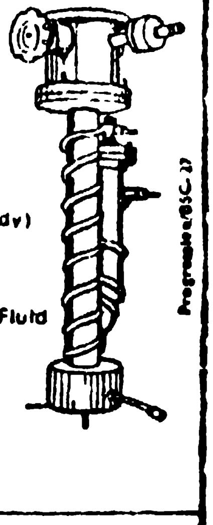

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December 1989 / Volume 55 / Number 12

A MONTHLY JOURNAL OF NATURAL & CULTURAL SCIENCES

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POPULARISATION OF SCIENCE : INDIAN CONTEXT

APARES BHATTACHARYYA*

SCIENCE has penetrated our society to an enormous extent so much so that even the most anti-science person cannot dismiss it as inconsequential. This is much more true, of course, in developed countries where the ultimate fruit of science and technology is reaching an all time peak and is directly expressed as the industrial and economic growth. In underdeveloped countries like ours, it is of no less consequence and it has already been recognised by our planners and leaders.

There is now widespread realisation of necessity of popularisation of science. The reason for this and the issues involved in it may differ from country to country or society to society. Whereas developed countries have made indepth studies in this regard, our country lacks systematic studies on this issue, the sporadic efforts of some voluntary as well as government organisations not withstanding. For example, in United Kingdom a programme on television called 'tomorrow's world' has been going on for last thirty years, based on popularisation of science which is telecast at the prime time in the evening. Response has been tremendous ; millions of people watch it, about one fifth among the viewers being school children.

We may ask questions as to issues involved in popularisation of science. There are two issues involved, one is fundamental, the other is practical The fundamental issue is that science has gone through a long and hard way and is now part of our culture. Thus directly means that interaction of science now involves all sections of the society—scientists, academicians and the public in general. This many questions are now raised including the ethics of science It is important that these questions are answered ; otherwise science will degenerate and will be dominated by technical considerations, the results of which will be devastating for the society.

The practical issue is no less important. In some quarters in developed countries it is said that without popularisation of science, the funding for scientific research may be stopped. It seems to be too harsh a view and certainly does not apply to present Indian context. Without having much statistics, we can say that scientists in our country are viewed with respect, affection and honour by the public as a whole. Of course, in U.S.A. a survey showed that scientists have such a place only next to physicians. The above qualitative generalisation seems to be correct in our society.

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*Council of Scientific & Industrial Research, New Delhi

The views here will be elaborated with few examples. Vast sections of our society are poor illiterate villagers who have very little concern about anything but the immediate bare necessity. Such a person—daily wage labourer in a village of Burdwan district in West Bengal—asked us about my research project ; he wanted to know what I do, what is the purpose of my work, and what are the implications. All his querries were answered about my work on anti-leishmanial drug development based on purine-receptor interaction at molecular level. He was very receptive and understood everything in his simple way and then he turned to my wife and told, "He is dedicated for the cause of human being. Beautiful. But take care. Such people go mad by thinking and thinking."

What a plain love, affection, respect and concern ! It is a strong base in our society from which we can start. Value and attitude is extremely important in science as it is in life. We have a strong base of value and attitude to science and to scientist in our society, though many of our country men are ignorant of science. We must cultivate it to develop this attitude based on common knowledge and facts.

True, it is very difficult to reach the illiterate mass. How to convey to them when they cannot even read. Literacy is a must. For the moment, to a small section of such people television may reach. Again such TV programmes need a lot of improvement to make it entertaining to be watched by such people. Even in this direction we have a long way to go.

Many agree that voluntary organisations are of much help in this direction. Dedicated workers of such organisation can be of much help because they have the human enthusiasm —crucial factor in such movements. However, such a novel work on a large scale needs money and material help which these organisations lack. Here, we must remember that government organisations have both, although they lack the zeal. Thus, combination of young vibrant workers of voluntary organisations with the material and money of government organisations can give the desired results. Many such 'joint movements', though occasional, have evoked great response from the public. "Bharat Vigyan Jatha" is one such example with coordinated efforts from all over the country.

However, sustained effort on large scale is lacking. Consistancy is important here. The existing localised efforts have to be encouraged, supported and coordinated.

Then there is the view of the scientist regarding his work. While reporting new discoveries to the public, this view is important. However, more often than not, a talented scientist always overemphasises the importance of his work in a way which hardly convinces the common man. While discussing his work a reputed scientist of Indian Institute of science put it this way : 'This kind of work of this laboratory is being done for the first time in the World.'

There is also the view of young scientists. After independence, scientific research in our country has seen an enormous change. More money has flown, number of Universities have increased enormously, research laboratories have been built in great number, and a huge number of trained scientific personnel have come up. Often there is frustration among scientists, often there is complaints of lack of research atmosphere and of harassment and torture of bright scientists. As a young scientist put it : In spite of all the glittering propaganda through media, one day our people will know about the useless activities of our laboratories. They will not forgive us."

Little has been done to rectify the situation inspite of occasional hue and cry about the problem. Science and scientific research are carried out by scientists with dedication and hard work. By their very nature they cannot fight for their rights through trade unions. For the shake of science and society, it is important that bright scientists are allowed to work. But as the conditions are, there is very little chance for a change. And the public is fully aware of this situation. An enlightened middle class person suggested to a young scientist, who had come back from abroad, to go back there again. He suggested this without any hesitation. He has his conviction about the non-scientific atmosphere in our laboratories !

The view of the so-called middle class is very important in our society. It is they who will make an impact on the future thinking of the society. Our middle class is literate and conscious. It is easier to reach them through public media. They are also keenly interested in scientific affairs but are more concerned about the immediate gains of scientific research, which is understandable. On one occasion, a middle class person bombarded me with questions to go into the depth of my research work. It was amazing to see his keeness. Experience has shown that they even listen to the lectures on origin of life with great interest.

It must be pointed out here that people should not be flooded with facts and figures only. This will lead to nowhere. What is important is the significance and implications of a discovery. So, an assessment of implications of a discovery is very crucial, and it is this in which people are interested.

Here, we must be cautious. Often our scientists make an exaggarated claim on their discovery, be it drug discovery or biotechnology or any other field, and publicize through popular media. Such a tendency may arouse great enthusiasm initially in the public mind, but ultimately it will degenerate into frustration and will do enormous damage to both science and society. This tendency must be checked. Wrong assessment of implication is injurious.

In an underdeveloped country like ours a lot of work can be done to popularise science. In our country such a movement can be directed to develop an attitude to science as its prime aim. Our aim and strategy has to be different from that of others to suit our social and economic conditions. Instead of putting importance only on latest discoveries, we can stress on a lot of existing phenomenon which are of direct consequence to the people. For example, in our cities television has invaded many houses. Its social implications we are really not aware of. Children and adults often watch programmes together. Advertisements have flourished and catch the attention of all, particularly the children. How long TV may be watched, from what distance, which programmes children should be discouraged—these are some of the things we must stress at present. Similarly, topics on deforestation, food habit, health, literacy, technology and problems of immediate and long term concern can be focused in a persistent and continuous fashion ; presentation must be enjoyable and lucid but at the same time correct.

Persistent efforts are not altogether absent in our country. An example is *Science Reporter* published by CSIR which has been making worthwhile contribution. Here again, we must keep in mind the public in general, and not just the scientific personnel, in popularising science. For this reason, two factors are important. Firstly, better results can be expected if we write in local language. Secondly, popular news papers and weeklies are much more accessible to the public than purely scientific magazines and journals. Hence, use of these newspapers and weeklies on regular basis will be more fruitful.

A nation with a healthy attitude to science and its ethical values should be the aim. If we can achieve this, it will be a tremendous success in making science and culture inseparable ; popularisation of science will take us a long way in this direction. Persistant, dedicated and hard work is necessary for this purpose. □

ABHORRENCE OF YOUNG BAMBOO SHOOTS BY GIANT PANDAS AND CLAIM OF CHINESE SCIENTISTS

R. N. CHAKRAVARTI*

It has been observed by Prof. Wang Xiangting of the Biology Department of Lanzhou University and his team, as reported by Xinhua and published in The Statesman, Calcutta of October 25, 1989, that a Giant Panda never hurts young bamboo shoots though it has a very big appetite and eats 20 kg of arrow bamboo leaves and tender twigs every day. During a close study in the Baishui River Nature Reserve, Gansu province, the Chinese scientists saw the Giant Pandas turn away from clumps of young bamboo shoots and that they would rather walk a long distance to search for fresh tree leaves and young grass than destroy young bamboo shoots, and for this reason they are regarded by Prof. Xiangting as **model protectors of natural environment**. He remarked—"That Giant Pandas do not hurt young bamboo shoots may be the natural instinct of the animal. Because of this, the Giant Panda, as a 'living fossil', has been able to survive three million years." He called the Giant Panda a "**gentleman among animals**".

The rare Giant Pandas, *Ailuropoda melanoleuca*, are found in the bamboo forests at high altitudes, up to about 4,000 m, mostly in central China and Tibet. They are fairly big in size, sometimes 90 kg in weight and 2 m in length and the body is covered mostly with white fur with black patches near eyes. ears, shoulder area and legs. This bear-like animal feeds extensively on bamboo twigs with leaves crushing those with their heavy teeth and powerful jaws. There is a raccoon-like Lesser

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Panda, *Ailurus fulgens*, with reddish brown fur and long, bushy ring-marked tail, living on insects, small mammals and birds, found in south eastern Himalayas. In spite of similarity in names, the two are quite different in size, shape, appearance and habits.

Giant Panda

Mother Koala with Baby at Back Eucalyptus Tree

The basic controlling factor of natural evolution is—*struggle for existence and survival of the fittest.* In this eternal process there is very little scope for gentlemanly behaviour. A hungry tiger will not spare a crying child out of kindness as a gentleman. The wolf-boys are quite special cases of human infants stolen and reared up by mother wolves, with breasts full of milk, having lost their young ones. Thus we had the wolf-boys of Uttar Pradesh, Dina Sanichar (rescued on a Saturday, 4 February 1867, died of tuberculosis on October 29, 1895), Parasram (rescued in April 1957, died of measles in 1960), Man Singh (rescued in 1905, died in 1960 at about the age of 65), Ramu (rescued on 17 January, 1954) and others and the wolf-girls, Kamala and Amala, of Midnapore. Speaking about instincts, one may note that almost all of them acquired immensely the habits and instincts of wolves, and in spite of all the serious care and efforts over long periods it was found almost impossible to rehabilitate them as normal human beings. It appears that at the tender age in some matters the environment may become more dominant than the gene so much so that some genes may become dormant even, particularly as at that tender age the brain cells are quite fresh and ready for programming for conduction of the rest of the life.

Leaving young bamboo shoots and taking the trouble of moving to a distant bamboo grove by Giant Pandas may be due to any one of the following reasons :

(a) as gentlemen they are kind and do not hurt young bamboo shoots ;

(b) as highly intelligent animals (cf. dolphins) they spare the young bamboo shoots and allow those to grow up so that they may eat their twigs and leaves, later, in plenty ;

(c) they avoid the young bamboo shoots just by instinct developed through generations after witnessing the harmful effects of eating the young shoots, due to presence of poisonous constituents in those.

As indicated above, it is difficult to believe that their abhorrence of young bamboo shoots is due to their gentlemanly character or their interest in functioning as model protectors of environment. It is also difficult to believe that the Giant Pandas spare the young shoots just in consideration of having continuity in their future natural stock of such foodstuff. Man is highly intelligent and yet we are taking out from the mines large quantities of fossil fuels like coal, petroleum, in quite an unplanned manner and cutting down trees in much greater number than we are actually planting without thinking about the future generations. Thus we are left with the third alternative, that the young bamboo shoots contain some toxic material which is injurious, or may even be fatal to them. It is quite likely that in the earlier stages of evolution many of them died after eating young bamboo shoots or had discomforts and thus gradually others became wiser in avoiding these as foodstuff. This *trial and error* system is practically as old as the biological evolution. After suffering like that for several generations, the Giant Pandas may have acquired, as instinct, their abhorrence of young bamboo shoots.

Biology is a multidisciplinary subject, not simply classical zoology plus classical botany, and chemistry has its very serious role in this branch of science. The structure of the Biology Department of Lanzhou University of China is not known to the writer, nor is it evident from the brief announcement, in the newspaper devoted to the spectacular claim in a popular way in a topical field, the basic grounds on which the inference is based. For instance, there is no indication about proper study of chemical aspects of the biological problem although this is essential before concluding about gentlemanly character of the Giant Pandas.

Let us take the case of the pretty, virtually tailless marsupial, arboreal bear, Koala, *Phascolarotos cinereus*, of coastal and eastern Australia. Australia is well-known as a land of living fossils, and the marsupials form an important group amongst them. Koala is possibly the most attractive amongst the fauna of Australia, a small fluffy lovable mammal, within 12-13 kg in weight, looking like children's 'teddy bear'. They feed almost exclusively on eucalyptus (gum tree) leaves, about 1.3 kg a day. They collect these in their pouched cheeks and eat leisurely. To aid in digesting these high essential oil containing leaves they have caecum (intestinal pouch) about 7 m in length. They are choosy not only about the trees but also about the particular leaves of the selected tree and for this reason it is often difficult to maintain them at the zoos. Unlike other tree-dwelling marsupials and Kangaroos, the Koala has the marsupial pouch with teats (marsupium) opening at the back. This is helpful for the safety of the young one under conditions of arboreal life of the Koala. The very premature baby Koala, just after birth while $\frac{3}{4}$ inch in length, crawls into the mother's pouch and grows up there during 5-6 months and then rides on the mother's back till about a year old, and is weaned by its mother's excreta showing the extreme care taken by the Koalas in choosing their food. Their choosy character with regard to the particular eucalyptus leaves does not show any kind of gentlemanly behaviour. They appear to avoid any poisonous material like cyanogenetic glycoside, beyond acceptable limit, in the eucalyptus leaves.

In this connection one may refer to the detailed and useful account of the *Sorghum* (millet, *jowar*) plants as published in The Wealth of India (Vol. IX, 1972, pp. 436-471), C.S.I.R., New Delhi. The Genus *Sorghum* belongs to the Family or Natural Order, *Gra-*

mineae, a genus of annual or perennial, usually robust, grasses including a large number of species extensively cultivated for grains *(jowar*, millet) and as fodder for cattle, etc. Millet is one of the earliest grains to be cultivated. In practically all the species of wild and cultivated *Sorghum* the poisonous cyanogenetic glucoside, dhurrin, *para*-hydroxymandelonitrile glucoside, is present at highly toxic level while the plants are young and not much in height or when these have stunted growth due to drought, etc., but when the plants are fully grown and particularly during and after flowering the concentration of this poisonous chemical becomes very low in the plant including the rhizomes/roots. The seeds are free from the toxic glucoside and are not poisonous unless infected with the fungus, *Claviceps purpurea*, a rare occurrence when the seeds become dark coloured and easily detectable. Such infected seeds may cause ergotism.

The cyanogenetic glucoside of immature *Sorghum* plants, or those having stunted growth due to drought or otherwise, breaks up during digestion, into the highly poisonous hydrocyanic acid and hence cattle may die after taking these, whereas mature *Sorghum* plants are good as fodder for cattle. Such domesticated (civilised !) animals have lost a lot of their instincts arising out of their dependence on man, and people maintaining them will have to be cautious in this matter. It may also be remembered that, under the evolutionary process, presence of the toxic materials in these plants at the young stage provides the plants due protection for proper growth. The young plants seem to tell the cattle—"Please do not eat us now. If you eat now, you will die as we are protected by our system developed through evolution. Let us become mature, bring forth our flowers and seeds for the next generation. We do not like to live beyond that stage. You will enjoy us most at that stage as fodder." Those with stunted growth, struggling to survive from effects of drought or disease, are also similarly protected.

Bamboos, the hollow, tropical giant grass, of the Genus *Bambusa* belong to the same family, *Gramineae*, as the *Sorghum*, and one should not wonder if young shoots of at least some of the species of *Bambusa*, out of 70 or so different ones, contain cyanogenetic glycoside or similar other toxic material as required for their protection during their growth period. An account of the *Bambusa* plants is presented in The Wealth of India (Vol. I, 1948, p. 153), C.S.I.R., New Delhi. *Bambusa* plants have a peculiar way of flowering. A few species flower in alternate years but most of the species flower after quite a long period and there are many which flower after well over fifty years and plants of the same species of an area suddenly flower all together. In some of the Himalayan areas, the author has come across hill tribes who believe that sudden flowering of all the plants of the area at the same time, after having no flowers over a large number of years, is indicative of forthcoming catastrophe like pestilence in epidemic form, death of king, earthquake, etc. Of course, a serious problem is created after the flowering as all the plants die after the seeds come out. The seeds germinate smoothly and gradually the new generation comes out, but for quite some time the local people suffer badly from want of bamboos which they require for their dwellings and for various other purposes. In plantations, however, they use more than one species in the same area to avoid this problem.

It is necessary to mention in this connection that young bamboo shoots are used as vegetable by people of some areas and for this purpose the little shoot, as it comes out of the clump, is covered up with an inverted earthen spherical pot (usual cooking pot). Under this dark enclosure the bamboo shoot takes more or less the shape of a light coloured cabbage. Presence of cyanogenetic glucoside in it does not affect the people taking it as food as it is usually well-cooked, and during cooking any hydrocyanic acid formed either escapes with steam or is further hydrolysed to harmless ammonium formate.

K. N. Bagchi and H. D. Ganguly isolated dhurrin, *para*-hydroxymandelonitrile glucoside, from young shoots of *Bambusa arundinacea* (Indian Med. Gaz., 1943, Vol. 78, p. 41 ; cf. N. N. Ghosh, S. Ghosh and R. N. Chopra, "Die chemische und pharmakologische Prufung der jungen Sprossen von Bambusa arundinacea", Arch. Pharm., 1938, Vol. 276, p. 351 regarding hydrocyanic acid of young bamboo shoots). It appears that the enzyme, emulsin, present in the young shoots, hydrolyses dhurrin to glucose, hydrocyanic acid and *para*-hydroxybenzaldehyde when the shoots are crushed and kept in moist condition, as it may happen during chewing by the Giant Pandas. It is not clear whether proper chemical investigation of the young shoots of the particular species of *Bambusa* of the Baishui River Nature Reserve of Gansu province of China has been duly carried out, as this is essential before making statements like 'Giant Pandas protect nature' or a Giant Panda is "gentleman among animals". If proper assessment is made on the basis of chemical and toxicological data, it will be observed that nature/evolution is protecting the young *Sorghum* plants, the young bamboo shoots, the Giant Pandas, the Koalas, etc. and the question of gentlemanly behaviour does not arise in such routine phenomena connected with balance in evolution. The main disturbance in this balance is being created by the so-called progress in human civilisation. □

HIGH LATITUDE MANGICULTURE : IMPORTANCE AND RESEARCH ACHIEVEMENTS

P. S. SHANT* AND A. S. BINDRA**

Mango starts reaching the market in India from March onwards. Most of the crop is harvested by the end of July. During August, even inferior mangoes like Fazli show a sky-rocketing of prices. After this time, the fruit virtually disappears from the market. In a little discussed zone, mangoes ripen precisely after this time and hold great promise both for domestic and export markets. This tract includes high-latitude and low-altitude districts of Jammu, Punjab and Himachal Pradesh. This paper deals with a survey of the major plantation areas in this part of the country. Salient achievements of research work done to encourage mango cultivation in this region have also been discussed.

After the month of August, mango virtually disappears from the Indian markets. Mango starts ripening in Cochin i.e. Kerala as early as February[1] followed by Tamil Nadu. Delhi market is supplied with mangoes first from South, then from Bihar and U. P. ; the latter produce reaches in June and July. Punjab mangoes are last to arrive in the market even though they happen to be the cultivars most popular in other North Indian plains, viz. Langra and Dusheri. There are three ways to extend the harvesting season :

(1) To adopt some cultural treatments including the use of growth regulators which delay the ripening ;
(2) To develop late-ripening varieties ;
(3) To improve the storage possibilities of the crop ;
(4) To explore area which are suitable for the cultivation of mango and have agro-climatic feature which induce late-ripening.

No major landmark has been achieved in the first two aspects while breeding work to develop late-ripening varieties is yet to be taken up. We resorted to this last-mentioned possibility. Not only this zone is good for mango cultivation but also has the additional feature of having such land as is not fit for cultivation for other crops. locally called *Kandi* area meaning thorny place Besides, the inhabitants of this zone are poor as compared to other parts of the country and are in deperate need to find some profitable agricultural enterprise. With these factors in view, a survey was made on the potential of mango cultivation in this region. Some experiments were also done to find propagation techniques for top working the existing wild mangoes and quick production of grafted mangoes for making new plantations.

Although a place at higher altitude may be as "cold" as the one at correspondingly higher latitude, the latter is more suitable for the plant growth[2]. Also in daylength sensitive plants, their response will not be identical under the two sets of climatic conditions. Thus, of the late-ripening mangoes the first one to ripen are those from the submontane tract of U. P. followed by that of H. P. and the Punjab and in fag end are mangoes from the Jammu region of J & K State.

Mango can grow in some cases up to 1,700 m above sea level in the Himalayas[3]. So low-hills

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of Sikkim and Bengal may also, in some cases be suited for the production of late-ripening mangoes. In fact, at an apple-fruit show in Lucknow held by Department of Horticulture, U P. Government, some samples of reasonably good mangoes were also displayed on September 1, 1984.

In this zone, most of the plantations are of seedling mangoes although some Dusehri plantations are also met with. No special survey has been conducted for mango and no accurate idea about the areas under this species is available. However, as per the estimates of the H. P. Agricultural University experts it is about 2000 hectares (ha) which includes the area understray and non-productive mango trees.

TABLE 1 : Areas in Himachal Pradesh under mangoes[4]

Block	Area
Nahan	Lower areas including Kala Amb and Kolar
Paonta	Whole of the Valley
Pachhad	Ginnighat and Mangarh
Shillai	Belt along Trauns river
Sangrah	Near Renuka and along the Giri River

In the Punjab, the following mango-growing areas come under the high latitude[5] : Dasuya, Mukerian, Gardhiwala, Dhar, Pathankot and Dunera.

It is the region comprising some parts of Jammu province, Punjab and Himachal Pradesh which holds the major prospects for the late-market mango. Places like Ambhar in Udhampur and Dinga Amb meaning twisted mango in Kathua district speak of the importance of these places for mango cultivation The south-west of the State is the most northerly situated mango zone which includes Rajouri district. Udhampur has the advantage of being towards north and at high altitude. The details of the various regions in the State are given in Table 2.

TABLE 2 : Area (ha) under mango cultivation in Jammu as in September 1984

Name of the district	Grafted		Un-grafted	
	Bearing	Non-bearing	Bearing	Non-bearing
Jammu	195	117	640	454
Kathua	8	140	160	634
Poonch	1	1	—	—
Rajouri	1	4	24	24

District	*Major plantation zones*
Udhampur	Reasi, Poni, Udhampur proper, parts of Ramnagar Majalta, Ambhar
Jammu	Marh, Samba, Kanachack, Tanda, Khor, Bhalwal, Chatha, Akhnoor, Dhiansar
Kathua	Hiranagar, Kathua, Dinga Amb, Bilawar, parts of Basoli
Rajouri	Rajouri, Sunderbani Nowshera

Regarding cultivation, mostly sucking mangoes are grown in grooves. However, there are few old-mango plantations which are existing in the form of orchards. So far as the number of stray plants are concerned they have not been estimated so far.

The time when mangoes ripen varies from variety to variety and place to place. Some sucking types are late-ripener and the fruits are available even from the middle of August to September. Established cultivars come into the market late in July. So far as variations in ripening time from place to place is considered, some varieties show as much as more than 10 days difference from one place to the other within this rather compact and small region.

Farmers prefer established types, viz. Bombay Green, Dusehri, Alphanso, Fazli etc. and have no awareness about the potential of late ripening mango cultivars. About 60% of the cultivated varieties constitute Dusehri. Alphanso is now being planted as much as Dusehri.

An increase in elevation does not produce merely a fall in maximum and minimum temperature[6]. The main differences in environmental factors due to elevated altitude and high altitude have been set in Table 3.

TABLE 3 : Important difference in evironments characterized by high altitude and elevated latitude

High altitude	High latitude
Less dust particles	More dust particles
More intense radiation	Less intense radiation
Radiation angle narrow	Radiation angle broad
More u.v. radiation	Less u.v. radiation
Less i.r. radiation	More i.r radiation
Short days in summer	Longer days in summer
Longer days in winter	Shorter days in winter
More ozone	Less ozone
Less pollutants in air	More pollutants in air
More difference between the shade and non-shadow areas as regards light and temperature	Less difference between shade and non-shadow areas as regards light and temperature
Less diffused light	More diffused light
For same total radiant energy, less photosynthesis	For same total radiant energy, more photosynthesis

Research achievements

At Udheywalla Fruit Research Station at Jammu, now with Sher-e-Kashmir Agricultural Sciences and Technology, some work on various aspects of local mangoes has been done, out of which the following may be highlighted.

Sowing time and depth : Stones separated from tree ripe fruits of a non-descript sucking

TABLE 4 : Percentage germination as influenced by various dates and depths of sowing during 1974

Depth	Germination per cent		
	July 17	July 27	August 4
Width stone	96.4	88.5	58.5
2-stone widths	86.4	70.0	17.1
3-stone widths	27.8	18.5	7.1

mango trees were sown in seed beds on July 19, July 27 and August 4, 1974 at a depth, equal to single double and tripple of the width of stone. A depth equal to width of the stone and early sowing were found to give best results (Table 4). Maximum germination of 96.4% was recorded with the stones sown on July 19. There was a substantial decrease in the germination of mango stones sown at latter dates and at depths beyond the width of stone.

Studies on stooling : Non-descript mango seedlings either of three weeks or three years age were headed back to 8 cm in July, 1973 and February, 1973 respectively. The dormant bud on the stubs when sprouted and attained 25-cm height were etiolated at the proximal end by mounding. Prior to earthing, thinning of side-shoots was done to avoid over-crowding where necessary. After a month or so, the mounds were dismantled, side-shoots ringed and treated with 5,000 ppm indolebutyric acid in lanolin. When the root initials were visible, the treated side shoots were remounted and left as such till complete root formation took place. The rooted side-shoots were later detached and planted in the field. The propagation method was a success and some 70 clones were obtained from 20 three-year-old plants and only 23 clones from same number of three weeks old plants.

Standardization of propagation method: Efficiacy of various methods of vegetative propagation for mango was studied under Jammu conditions. The percentage success in simple inarching was maximum in both the years of study i.e. 1970 and 1971 followed by veneer grafting. While forkert budding was a complete failure in spring, the results of modified inarching were also not encouraging.

TABLE 5 : Response of mango seedling to stooling treatment under Jammu conditions

Age of plants	Season	No. of plants treated	No. of side shoots produced	No. of stool prepared
3 years	Spring, 1973	20	106	70
3 weeks	Rainy, 1973	20	32	23

TABLE 6 : Average percentage success in veneer grafting of mango as influenced by various degrees of defoliation of scion wood

Treatment	Success per cent obtained					
	Spring season			Rainy season		
	Feb.	March	April	July	Aug.	Sept.
Completely defoliated scion wood	56.60	50.00	20.00	83.33	73.33	26 66
Partially defoliated scion wood	46.60	43.30	13.30	56.66	66.66	26.66
Undefoliated scion wood	36.60	40.00	10.00	53.33	43.33	20.22

Veneer-grafting experiment : The use of completely defoliated scion gave higher percentage of success in both the seasons (Table 7) as compared to other treatments. The success was better in rainy season than the spring season and a maximum success (83%) was recorded in July grafted plants.

year the success was as follows : May 5, 50% ; July 31, August 28 or September 25, 50%.

In-situ planting : Instead of bringing crop-land areas under mango plantation, the possibility of extension of mango plantation in mild *kandi* (dry thorny forst) areas was considered. But due to acute water shortage, the grafted mango plants did not establish themselves. So the possibility of raising mango orchards *in situ* was tried.

Pits of 1 × 1 size were filled with top soil, 250 gm of 10% B.H.C. dust and 10 kg farm-yard manure. Three to four stones were sown per pit in the first week of July. The seedlings from these stones were veneer-grafted in next July with Dusehri, Langra and Malda scion wood. The resultant graft sprouts were protected from frost and heat injury and

TABLE 7 : Success of different mango-propagation techniques under Jammu conditions

		Success per cent obtained					
		Rainy season 1970			Spring 1971		
		July	August	Average	Feb.	March	Average
Veneer grafting	Dusehri	60	67	63	75	73	74
	Langra	53	70	62	75	71	73
	Malda	47	60	53	80	67	73
Simple inarching	Dusehri	65	70	68	90	93	92
	Langra	70	70	70	90	97	93
	Malda	65	70	68	100	97	98
Forkert budding	Dusehri	30	30	30	—	—	—
	Langra	35	30	32	—	—	—
	Malda	15	—	8	—	—	—
Modified inarching	Dusehri	55	NT	—	5	—	2
	Langra	50	NT	—	15	10	2
	Malda	20	—	15	20	18	—

Top-working of semi-wild mango trees : Besides proceeding with the plantation of cultivated type of mango trees, top-working of the existing old seedling plants into cultivated types of choice was also tried. Studies were, therefore, undertaken to perfect the time of the operation. Eight-to-ten year old trees were headed back and side-grafted on different dates in June, July and August. Maximum success of 60% was obtained with tree top-worked on 3. 7. 1972. For other date of the excessive transpiration by thatching in winter and summer. The moisture-conservation practices, involving the use of heavy dozes of farm yard manure well mixed in the soil and mulching in summer months, were adopted. The basin around the grafts was kept free from weeds.

The plants were left to natural showers and no artificial irrigation was applied. Of the three to four grafts in each pit, only one healthy and stout one was finally retained and the rest removed. The care and management practices were given for the first four to five years when the plants developed a deep root system to draw their water requirements from greater depths in the sub-soil and got acclimatized to *kandi* conditions. A success rate of 70% could be achieved by these practices. □

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COLD FUSION*

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FUSION is a process in which two light atomic nuclei fuse together under certain circumstances into a heavier nucleus and release energy. Fusion is indeed, the energy source of the sun. When the fusion energy was released early in the fifties by scientists, great hopes were entertained that man could utilise this unlimited energy present in our oceans. Though the scientists could harness the fission energy, released a few years earlier in a short time, taming of fusion power has yet eluded many a concentrated effort.

In physicists fusion experiments, such as the ones conducted in plasma physics laboratories all over the world, the work revolves around one simple fact : to produce fusion at a usefully energetic rate, the fusion fuels must be heated to a temperature of a hundred million degrees Celsius. This is a temperature so high, so far beyond our ordinary experience or comprehension, as to represent a concern that we name rather than grasp. At temperatures of only a few thousand degrees even the hardest forms of steel flash into gas. At hundred thousand degrees electrons start escaping from the atoms. An ionised gas made-up of ions and electrons is called plasma.

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*Based on a radio talk broadcast from Calcutta Station on 20. 9. 1989.

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Plasmas are different from ordinary gases, they conduct electricity. Thus it is possible to confine them by powerful magnetic fields.

In fusion experiments, in many of the laboratories of the world, the plasma is often composed of ordinary hydrogen. Tomorrow's fusion reactors will rely on more energetic reactions. The most interesting of these employ deuterium and tritium : the heavy isotopes of hydrogen. These have nearly the same chemical properties as ordinary hydrogen, but differ in the structure of the atomic nuclei. This substitution of isotopes for the hydrogen raises the reaction rates to useful level.

Deuterium is abundant in sea water. For many years, it has been extracted in a straight forward way, in quantities measured in tons, for use in certain types of nuclear reactors. Indian reactors do require heavy water and we have a number of heavy water plants in the country. The technology of obtaining heavy water, where the hydrogen atoms have been replaced by deuterium atoms in the water molecule, is well understood.

It is said that in 1960's when Glenn Seaborge was the Chairman of the Atomic Energy Commission in the United States he impressed upon the legislators about the power of deuterium by following remarks : deuterium in the world's ocean amounts to the energy equivalent of five hundred Pacific Oceans brimfull with the highest grade of fuel oil. To understand it in another way—everytime one drinks a cup of coffee, one is downing enough deuterium to provide energy to run a car for a week.

The above statements are enough temptations to pursue fusion research all over the world and since the last almost forty years several laboratories are incessently working at it, solving one problem after another to achieve the ultimate goal. This maddeningly slow but steady progress of fusion research got a severe jolt in the month of March of this year when two unknown chemists, who never worked with fusion, announced in the press that they have found a way to achieve fusion of deuterium nuclei at room temperature in a test tube.

It was a bolt from the blue on the scientific world when two chemists B. Stanley Pons from the University of Utah (USA) and his British Colleague Martin Fleischmann announced on 23rd March 1989 at a Press Conference that they have measured far more heat energy emerging from an electrolytic cell than they put into it (in the form of electricity). In their cell an electrolytic current passes between palladium and platinum electrodes immersed in a solution of heavy water and lithium. The current splits the heavy water into its atomic constituents, oxygen and the hydrogen isotope deuterium.

The contention of Pons and Fleishmann is that the deuterium nuclei in their experiments, instead of reforming into deuterium gas and bubbling out of the container as would happen with most other electrodes, pack into the unusual palladium metal at such high densities that some of them fuse. They concluded that the excess heat is due to the poorly understood nuclear events.

In a second revelation, less spectacular than the first one, in the same month, Steven E. Jones of Brigham Young University in Provo, Utah, informed a gathering of physicists at Columbia University that he along with his co-worker have evidence for extremely low levels of cold fusion, occurring in an electrolytic cell. Jones said his group observed modest excesses of what appeared to be fusion produced neutrons emitted from titanium electrodes, though the levels measured were so miniscule that no excess heat would be observable.

Since these March announcements a handful of perhaps hundreds of hastily assembled cold fusion research groups world-wide have reported evidence that provisionally confirms some of the earlier observations mostly these of Jone's group. In India too researchers from Bhabha Atomic Research Centre, Bombay; Tata Institute of Fundamental Research, Bombay; Indira Gandhi Centre for Atomic Research, Kalpakkam and Variable Energy Cyclotron, Calcutta, rode the band wagon with their extensive resources and added their voice to the conclusions arrived by majority of scientists in the field. Many small university laboratories also staked their claim to the experiments but hardly anyone reported the results. The vast majority of the labs have found no signs for either the excess heat claimed by Pons and Fleishmann or small excess of possibly fusion—produced neutrons claimed by Jone's team.

Robert A. Huggins of stanford University claimed towards the end of April that he observed excess heat though he did not try to explain. His work came under severe attach at a meeting of a Material Research society in San Diego. Scientists in the audience raised objections ranging from faults in Huggins overall experimental design to possible interpretational pitfalls based on subtle experimental details.

In the Baltimore meeting of the American Physical Society, Chemist Nathan Lewis of the California Institute of Technology in Pasadena made a scathing refutation of Pons and Fleishmann's claims. He described an exhaustive series of experiments in which he and co-workers explained all of Pons and Fleischmann's original lines of evidence as the results of either faulty assumptions in their calculations or poorly controlled experiments.

Towards the end of April this year the weekly Nature published in the News and Views section an interesting debate surrounding a claim in the 1920s of Fritz Paneth and Kurt Peters that ordinary hydrogen absorbed in palladium fuses to form helium. In April 1927, eight months after their first paper was published, Paneth *et al* retracted their claim as they had underestimated two sources of errors. But the results had already caught the fancy of many a researcher and in 1927 John Tannenbaum of Electrolux Research Laboratory applied for a Swedish patent of a device which produced Helium and useful energy. This invention was an electrolytic cell using ordinary water and based on the work of Paneth and Peters. However, the patent was never granted.

The above episode in the history of science is an interesting parallel to the present situation regarding the 'cold fusion'. Though Pons and Fleischmann Violated the scientists' norms by going to press prior to a poor review, the general interest created by the announcement amongst the public is noteworthy. Whether the scientific community is ultimately going to prove the effect to be "no effect" the enthusiasm generated will go a long way to boost up the conventional fusion research. ☐

MAN AND NATURE*

S. K. MITRA*

I consider it to be a great privilege to have this opportunity of presiding over the Anniversary Meeting associated with the Silver Jubilce Celebration of the National Institute of Sciences of India. It is fit and proper that I begin my address on this occasion with a brief history of the Institute founded with the object of promoting the knowledge of Nature including its application for gaining increased control for the welfare of Man with special reference to India.

In the year 1934, the late Dr. M. N. Saha, following certain proposals made earlier by the Government of India, and in accordance with the wishes as expressed in certain resolutions adopted at meetings of representative scientists of the country, suggested, in the course of his Presidential address at the 21st Session of the Indian Science Congress at Bombay, that steps should be taken for the formation of an 'Academy' of Sciences in India. The suggestion was discussed in a special meeting of the General Committee of the Indian Science Congress, and a representative committee, called the Academy Committee, was set up to work out its details The Committee worked for a whole year, overcame many difficulties, compromised many differences and submitted a detailed note on the constitution and the aims and objects of the proposed Academy under the title National Institute of Sciences of India. These were accepted, and, on 7th January, 1935, the Institute was founded at a meeting held in the Senate House of the University of Calcutta under the Chairmanship of Dr. J. H. Hutton, President of the Indian Science Congress Association of the year. The Institute was inaugurated by Sir John Anderson, the then Governor of Bengal, and the inaugural address was delivered by the first President of the Institute, Sir Lewis Fermor. What Sir John Anderson, a noted administrator who had begun his life as a student of science, said on this occasion is worth recalling today : Said Sir John, 'I have never regretted the scientific training which I received during some of the most impressionable years of my life. I have not regretted it because I think that the detached outlook of the scientist may be an asset to an administrator. Conversely I think that a knowledge of practical administration must often be helpful to a man of Science....' This remark of Sir John Anderson—the desirability of the administrators having training in the scientific method and of the scientists in the administerial procedures remains as forceful today as it was a quarter of a century ago. Nay, it is more so when the policy maker, the administrator, the scientist and the top executive have to work shoulder to shoulder, in close co-operation for economic planning and for the successful implementation of the planned projects.

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*Being the Anniversary Address, by the President at the Silver Jubilee of the National Institute of Sciences of India at Delhi, on December 31, 1960. Published in *Science* and *Culture*, February, 1961

As I have just said, the Institute was founded to function as an Academy of Sciences. The model of its constitution adopted for the purpose was that of the Royal Society of London. The rules for election of Fellows are similar. and there is also restriction regarding the total number of Fellows to be elected (400). About ten years after the foundation (during 1943-45) the question of the recognition of the Institute by the Government of India as the representative body of scientists in the country was taken up. There were negotiations and discussions in which Professor A. V. Hill, the then Secretary of the Royal Society, who was in India at the time to advise the Government on the co-ordination of scientific researches in India with corresponding investigations in Great Britain, took active part. As a result, the Government, in 1945, decided to recognize the National Institute of Sciences as the premier society representing all branches of science in India. There were certain provisos, such as that the headquarters of the organization are to be at Delhi and that the Institute should have a Charter and should have statutory powers on the model of the Royal Society of London. The headquarters, which had been at Calcutta in the buildings of the Asiatic Society, were accordingly shifted to the Delhi University buildings. From the year of this recognition the Government had commenced giving increased grants to the Institute to meet the expenses for publication, research fellowships, publication grants to scientific societies and other costs. A capital grant for its building was also sanctioned in the same year. In April, 1948, the foundation stone of its own building was laid by the Prime Minister of India, and its essential portion being completed in 1951, the Institute moved to its own premises. The Institute has also been informed earlier, in 1945, that the question of granting a Royal Charter had been 'taken up with His Majesty's Government'. However, on the country gaining independence soon after, the matter was not pursued. Another question, namely, that of the recognition of the National Institute as the adhering body of the International Council of Scientific Unions and of its allied organizations, was taken up with the Government in 1947. It is, however, still undecided. Very recently the Ministry of Scientific Research and Cultural Affairs wanted to know how the N.I.S.I. may be developed on the lines of the Royal Society of London. Suggestions have been made in this regard and the matter is under consideration.

Science in India

The Council of Scientific and Industrial Research

What has been the progress of science in India in the 25 years since the foundation of the Institute ? The progress can be gauged by the increase in the number of research laboratories, of research workers and of the scientific journals published in the country. A good index of the progress is the increase in the membership of the Indian Science Congress, the sponsoring body of the National Institute. Whereas the number of members (of all categories) enrolled in 1935, the year of inauguration of the Institute, was 907, that in January this year was 5,638, a six-fold increase.

Much of this increased scientific activity has been due to the support which scientific research began to receive from the Government with the establishment, in 1940, of the Board of Scientific and Industrial Research, which later became one of the component units of the wider organization, the Council of Scientific and Industrial Research. Indeed, the adoption of the policy of sponsoring and encouraging scientific research at the government level—though at the time it was 'actuated more by the urgent considerations of possible Axis aggression than to any national development'—was the greatest single event in the history of the progress of science in the country in the last quarter of a century. It is gratifying that the policy did not change with the cessation of hostilities. It was rightly so, because, though the war had ended, the Axis combination of more powerful foes—poverty, ignorance and disease—remained. And, the combination could only be fought with the aid of science. The C.S.I.R., therefore, very justifiably continued to exist, doing its useful work, sponsoring and helping scientific and industrial research and is now a wing of the Ministry of Scientific Research and Cultural Affairs.

It is to be recorded that the expansion of the activities of the C.S.I.R., with its National and Regional Laboratories, Research Committees, and sponsored research schemes, research scholarships and research fellowships and grants for scientific publications, has been due almost entirely to the imagination and initiative of our distinguished past President the late Dr. S. S. Bhatnagar, with the active support of the Prime Minister.

I would take this opportunity of mentioning the names of two other past Presidents for their conspicuous work in connection with the most important of our national activities—Economic Planning. The late Dr. M. N. Saha, for more than a decade before the launching of the First Five-Year Plan, had preached through press and from platform to educate the then Government and the public on the essential need of such planned effort for a backward country like ours. The contribution of our immediate past President, Professor P. C. Mahalanobis, to the drafting of the Second Five-Year Plan and his continued association with the Planning Commission are well known. We may also note that our incoming President Dr. A. N. Khosla is also a member of this body.

Progress in Science and Technology—Man's Control over Nature

It is interesting to recall today the state of science and of technology—Man's control over Nature—as it was 25 years ago at the time of the foundation of the Institute and to take stock of the progress made since then. A physicist of 1935 could very well have said that the fundamental discoveries made since the closing years of the last century had already laid the foundation of the physical sciences and that further progress meant only filling odd gaps here and there. The claim was indeed justified. The four decades 1895 to 1934 gave us radioactivity and X-rays; relativity and quantum mechanics; photon, electron, proton and neutron; electronic structure of atoms and the physics of the molecules; cosmic rays and the expanding universe. Keeping pace with these discoveries in the physical sciences there were remarkable advances in the life sciences also: Discovery of vitamins, artificial parthenogenesis, carcinogens; development of bioelectric techniques for research and diagnostic purpose (ECG and EEG), Pavlov's conditioned reflex, Freudian psychoanalysis, and the beginning of a major breakthrough in the art of healing by the discovery of antibiotics. The decades also ushered in the air age and the radio age accompanied by revolutionary changes in the modes of transport and communication. The former followed the developments of internal combustion engine and the latter the invention of the thermionic valve. Distances measured in weeks could now be covered in days by air whilst message-modulated electromagnetic waves could encircle the globe via the ionosphere, in a matter of a tenth of a second. In the wake of these revolutionary developments came as educator and entertainer, broadcasting, movie and talkie. All these affected not only the everyday life of man, but also international relations. Truly, the world had become smaller.

These were formidable achievements indeed and could justly be called epoch making. Nevertheless even a cursory survey of those during the last quarter of a century shows that the discoveries and technological advances increasing Man's control over Nature, as made during this period, are no less outstanding. The three great landmarks of progress during this period are the inauguration of the atomic (or rather nuclear) age in 1945—inaugurated unfortunately by a demonstration of its destructive might only, the discovery in 1954 of the part played by nucleic acids (DNA generally and RNA in some cases) as carriers of genetical instruction and the advent of the space age in 1957 heralded by the launching of the first man-made satellite of the earth. According to many authorities, of the three, the second is the most important achievement of this age, far surpassing the other two in its potential effect on the future of the human race.

Besides, this period witnessed the development of new branches of science and technology and of new techniques for exploring nature and serving human needs. Thus have developed radio-astronomy and radio-telescopes ; electron microscope and atom smashing synchrotons ; radar and transistors ; and cybernetics and automation. The last named, a child of Electronics (which acquired serious meaning only during this period), is ushering in a second industrial revolution. The first revolution—which started some two hundred years ago—had freed man from the drudgery of manual labour by providing him with power driven machine ; the second is releasing him from the bondage of many types of mental labour by endowing the machine with sensory complexes simulating the human brain. And, in our everyday life, to mention only a few at random, have appeared the jet plane, television, magnetic recorder and the various kinds of plastics and insecticides. It has truly been said that we are living in an age of explosive progress in science and technology.

To what has this explosion been due ? The exigencies of the two World Wars, specially the second one, has certainly been a great contributory factor. The Governments of the belligerent countries were vitally interested in the development of new instruments of offence and defence and they sought the aid of scientists and technicians for the purpose. The scientific man-power and the industrial resources of the respective countries were thus mobilized for research and development. The results obtained were beyond all expectation, and the lesson was learnt that fundamental research was at the root of all progress. This was not forgotten when the hostilities ended. Generous support continued to be given to scientific research, both by Governments and by many of the larger industrial establishments : the former because of its continued defence interests, and the latter, because such researches were expected to bring in rich practical dividend.

The second factor responsible has been the adoption of a policy of planned attack, supplanting largely the lone effort of individual scientific worker. Specific problems are now subjected to intensive study by research teams consisting of workers from many disciplines 'fusing their talents and techniques'. Chemists work in collaboration with physicists and mathematicians, biologists co-operate with the chemists and the physicists, and medical sciences requisition the aids of all the basic sciences and of the latest electronic and mechanical engineering devices.

Finally, it is not a one-way trafic—wherein science only promotes technology ; technology in its turn reciprocates by providing new and powerful tools for experimental research. Science and technology, helping each other, have contributed significantly to the quickening of the pace of progress.

Man and Nature

Alongside of science, gaining greater and greater control over Nature, there is persistent effort to penetrate deeper and deeper into Nature to understand it and interpret it in all its aspects. However, in the course of this effort, by observation and by application of reasoning, the scientist has come to a stage beyond which he cannot proceed ; this holds both in the case of the physical world and in that of the biological world. Boundaries of knowledge appear to have been reached which cannot be crossed. This is due not any lack of experimental technique or to inadequacy of the dialectic tool but to the very nature of things inquired into. The situation has made the scientist face questions which belong to realms of metaphysics and philosophy. We find today top-ranking scientists concerning themselves with such questions as coexistence of the external and the internal world, the possibility of the natural laws being products of the human mind, relationship between the observer and the observed and that between mind and matter, and the criterion of certainty. It seems strange that a scientist whose job, according to popular conception, is to create and satisfy material needs through discoveries and inventions, should have to face questions of philosophy which were once thought to be mental exercises only.

I will take the liberty of making a few observations on the situation that has thus arisen and the attitude of the present-day scientists towards it. Let me first recapitulate briefly how limits have been set upon our knowledge in three widely different fields of scientific enquiry: The world of atoms and sub-atoms, the cosmic world and the world of life.

The atomic and sub-atomic world. In this world where space and time are measured in millionths and billionths of their respective units (cenitmetre and second), the limit is imposed by the famous Uncertainty Principle based on the experience that an observer cannot carry out any observation without disturbing the state of the observed object. The observer with his equipment is, in fact, an inseparable component of the observed in any process of observation. As a result, it becomes impossible, even in principle, to make simultaneous precise measurement of pairs of quantities like position and velocity of a body for predicting its future state of motion. The limitation is of little consequence when the scale is large. But, for the atomic and sub-atomic world it becomes important and far-reaching. We cannot, for example, form a detailed picture of the motions of electrons round an atom. We have to remain satisfied with only a hazy picture representing our uncertain, probable knowledge. Take another example. A particle on one side of a thin screen, with two closely spaced holes in it, is found to be on its other side at a later time. In common parlance we say that the particle must have passed through one of the holes to the exclusion of the other. Such statement cannot be made if the particle is an electron. On the other side of the screen our working knowledge will be, it has passed through both the holes !

The indeterminacy of our knowledge also follows from a consideration of the well-known dual character of matter and radiation. Matter (electron), in one set of experiments, presents the picture of wave motion ; in another set that of particles. So also is the case with radiation (photon). Each kind of picture is, however, incomplete in the sense that it does not give all the precise information necessary for predicting the future state of the entity—matter or radiation. Our knowledge of the state as gained from experimental observation is thus always indeterminate. The limit to which one of the two picture analogies may be 'pushed', without contradicting the deductions as may be made from the other, leads to the mathematical formulation of the uncertainty principle.*

It should, however, be mentioned that the sacrifice of certainty and the limitations in our knowledge of details has its compensation also. To give one example, the fundamental principle that no distinction can be made between two electrons, when pursued logically with mathematical reasoning taking account of the consequences of 'indeterminacy', tells us how the two atoms of a hydrogen molecule are held together (Exchange Force).

The cosmic world. In the study of the cosmic world—space strewn with galaxies and their clusters—where distances are measured in hundred and thousand millions of light-yearst† and the evolutionary history in similar figures in years, the famous 'Red Shift' sets a limit to our possible knowledge of the Universe Observations show that the more distant a galaxy or a galactic cluster is the redder it is. The interpretation of this strange result, according to the well-known Doppler Effect, is that the galaxies are receding, the velocity increasing with distance : Every increase in distance by a million light-year, increases the recession speed by about 30 km/sec. For a galaxy at a distance 10,000 million light-years, the speed is about that of light. The intensity of radiation received from such a galaxy is nil and, so far as a terrestrial observer is concerned, it is disappearing over his observable horizon.‡ Our knowledge of the extension of the Universe in space and time is limited by this horizon—10,000 million light-years away. No increase of the power of the telescope will enable us to explore regions in space or epochs of time in the past beyond those fixed by this limiting figure.

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*According to Bohr the duality is not inherent in the photon or electron. It is the mode of observation, the experimental apparatus employed, that, depending upon its nature, makes the entity appear either as wave or as particle. No experiment has yet been devised by which both the pictures may be obtained simultaneously. The two pictures which they present are not contradictory, but complementary. Our difficulty in describing the situation arises in the limitation of our language which was invented to describe experiences not concerned with processes occurring within atoms. Only the things of which we can form mental picture, as a result of our daily experience, can be described by our language. A logical consequence of the 'complementarity' of the particle picture and the wave picture is thus, that it is not possible to assert categorically the state in which the fundamental entity (electron or photon) exists between two acts of observation This means that we have to give up the idea of objective existence, say of electrons, independent of any observer. This extreme standpoint is not, however, favoured by Einstein's school.

† It is well to recall that a light-year is equal to 9.5×10^{12} km., that is, about 64 thousand times the earth-sun distance.

‡ According to a recent report—the farthest galaxy observed—with both optical telescope and radio-telescope—is receding at nearly half the speed of light. It is thus not far from the 'edge' of the universe.

Our possible knowledge of the future of the universe, and, generally of its large-scale behaviour, becomes also limited if we accept the latest cosmological theory, the Steady-State Theory. According to this theory the matter disappearing over the 'horizon' is being continuously replaced by creation of new matter. Combined with the 'homogeneity hypothesis',* the theory means that observed from any position in space—from another galaxy, for example, or at any other epoch of time, past or future, the universe always presents the same picture : Space strewn in all directions with similar patterns of receding galaxies and galactic clusters, new galaxies forming out of matter continuously created, galaxies ageing and ultimately passing out of sight. Nothing more can be learnt about the large-scale behaviour of the universe than we can learn from the position we occupy.†

The world of life. In the world of life, the boundary of scientific knowledge still is what separates the world accessible to the senses, the external objective world, from that of feeling and consciousness within, the internal subjective world. The boundary persists (its seat is in the brain of the scientific worker himself !) notwithstanding the remarkable advances made in new fields of the science of life, like molecular biology and brain-body relations. Living molecules have been discovered which produce their replica by duplication of suitable environment ; chemical compound has been identified which regulates social life of certain insect communities (bees) ; physiological stimulation of certain brain centres has been found to bring into the realm of consciousness one's past experiences ; it has been shown that one's mental make-up is dependent on circulatory hormones, and it is claimed that just as the physical sciences have given us control over the physical world, so the life sciences will one day enable us to control the internal world. We are nevertheless still ignorant of the nature of the psycho-physical coupling which transforms a nervous impulse ending on certain parts of the brain to conscious sensation, though, with the aid of modern electronic apparatus, we may trace the propagation of the impulse along a sensory nervefibre from a receptor end-organ to the coupling point.

Consideration of these illustrations, drawn from three widely different fields of scientific endeavour, gives one the impression that Nature, under one pretext or another, refuses to give up her ultimate secrets. Why this should be so ? The dogma that these are things too impious to search for, too wonderful to know is repugnant to scientific mind. A scientist today would rather agree with the view, held by many eminent men of his profession, that the basic assumption of scientific enquiry, that there exists a real world of matter and energy in space-time independent of the observer, does not perhaps represent the whole truth. The observer is perhaps an inseparable part of the world he is observing. He has stepped out of it only for the sake of convenience, to systematize his knowledge of what is outside of his self. He has thus unwittingly and artificially dichotomized Nature into an internal subjective world and an external objective world. He now wants to step back into it to have a closer view. The result is confusion : part trying to understand the whole. It is easy for the scientist today to agree with the philosophy that Man is one with Nature, that mind and matter are only different facets of a single reality and that if the laws of the external world are creations of the human mind, the existence of the human mind requires indispensable partnership with Nature.

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* The 'homogeneity hypothesis' postulates that in the large scale, ignoring local small-scale irregularities, the galaxies and the galactic clusters are homogeneously distributed. This, in other words, means that the universe as a whole is isotropic not only about our position but about any position. The former may be inferred from the finding that so general a property as the motion of the galaxies is the same for all directions. But, if the universe were isotropic about our position only, the terrestrial observer would be in a highly favoured position, at the centre of the universe as it were. This is very difficult to accept for philosophical reasons.

† As an alternative to the Steady-State Theory there is also the Evolutionary Theory. According to this theory, the universe was created some 10,000 million years ago with the explosion of a highly dense mass of matter—the 'primeval atom'. The receding galaxies are the result of this explosion. The theory may be justified mathematically. But it leaves one unsatisfied. How and when was the dense mass of matter created and what was the state of affairs before this creation ? If matter could be created out of nothing once, why cannot it be so created continuously ?

The Future of the Institute

In concluding my address I would like to remind the Fellows that of the 120 Foundation Fellows with whom the Institute started in 1935, only 42 are in the land of living today. They all—and I happen to be one of them—rejoice on the Institute completing its 25 years of fruitful existence. The future of the Institute now rests with the younger generation. This is as it should be. An individual's life is limited, an Institution's need not be so. It may remain perpetually alive, being ever rejuvenated by the infusion of youthful blood. I am sure our youthful Fellows on whose efforts and activities the future growth of the Institute depends are alive to the fact that we are living in an age of scientific revolution when application of science and technology to the welfare and economic progress of a nation is a vital issue and when, as never before, there is urgent need of strengthening the activities of an institution like ours. They will, I have no doubt, spare no pains to do and perform all such 'acts, matters and things that may assist in, conduce to or be necessary for the fulfilment of the aims and objects of the National Institute'. □

OBITUARY

SANTOSH KUMAR PAIN
(1924-1988)

SANTOSH Kumar Pain left for his heavenly abode on the first day of May, 1988 at Santiniketan, leaving behind his wife, a daughter and a son, and a number of students, friends and well-wishers to deeply mourn his premature death. In fact, he was to celebrate his 64th birth anniversary on that fateful day. It was really painful that he passed away just one year before his retirement from active service.

Born on the first day of May, 1924, in a renowned family in Calcutta, Pain had his early education in Hare School, Calcutta, from which he matriculated in 1940. He was a very bright student from his very school days. In 1944, he graduated with Honours in Botany from the Presidency College, Calcutta and passed the M.Sc. examination in Botany in 1946 with specialization in Plant Physiology from the Calcutta University, ranking first in the first class. After obtaining his Master's degree, he joined as Senior Research Assistant in an I.C.J.C.'s scheme under late J. C. Sengupta in 1947. He served as lecturer in Botany at the Central Calcutta College (now Moulana Azad College) under W.B.E.S. from 1950 to 1957. He then left for King's College, London, on a State scholarship to carry out research under the illustrious guidance of late T. A. Bennet-Clark, P.R.S., where he made valuable contributions in the area of polar transport of growth substances with special reference to geotropism. In recognition of his research contributions, he was admitted to the degree of Ph.D. of London University in 1960. After coming back to India, Pain joined the Presidency College, Calcutta, where I first met him as my teacher. He was promoted to Asst. Professorship in 1961. He served the Darjeeling Govt. College from 1965 to 1969 as Head of the Botany Department.

He gave up Govt. service and joined the Department of Botany, Visva-Bharati, Santiniketan, as Reader and Head in 1969. Through his untiring efforts, the post-graduate course in Botany was introduced in Visva-Bharati in 1970. It was at that time when he requisitioned my service as a part-time lecturer there and I had the opportunity to know him as a colleague and also as a sincere and devoted leader of academic pursuits The post-graduate department of Botany at Visva-Bharati thus owes him a great deal for making possible of its establishment despite limited resources available at his disposal and in view of political turmoil prevailing over this state during that time. When the dream of introducing the post-graduate curriculum in Botany came to a reality, Pain started dreaming of a bright future for this department. He established a research unit in Plant Physiology, within a short period, this unit earned recognition from the academicians of the country as a centre for higher studies in Plant Physiology. Despite constraints of various nature he had to face at the initial stage, it was Pain's stubborn efforts and indomitable zeal that have made possible the department of Botany of Visva-Bharati to emerge as a centre for higher studies in Botany in this country.

He had an illustrious research career as well. Several students obtained their Ph.D. degree under his able guidance. His major interest in research centered around problems pertaining to various aspects of the physiology of economic and socio-economic plants Most of his research students have occupied responsible positions in different seats of learning. He had 45 research papers to his credit, published in reputed journals of home and abroad. He was associated with various academic bodies of different universities, research institutes and learned associations. The Indian Botanical Society accorded felicitations to Pain in recognition to his contributions and interest in research in Plant Physiology at the Seventh Botanical Congress held at Jaipur in 1984.

Going back through the corridor of time, I happily reminisce my association with S K. Pain, first as my teacher, then as my colleague and as my all-time friend and well-wisher. I have had thus an opportunity to see him from close corners. A man of amiable disposition with a good sense of humour and unquestionable professional integrity, Pain was loved and respected by his countless students. His dedicated contributions to the cause of Botany in general and of Plant Physiology in particular will be remembered by all in the years to come. In the death of Santosh Kumar Pain, we have lost a renowned botanist, a dignified teacher and a friend of all who came to his contact.

Monojit A. Choudhuri

Notes and news

Aspirin cures heart diseases

Aspirin being one of the oldest amongst the synthetics and one of the oldest surviving drugs is still going strong as a pain reliever. It is a very much effective, readily available and a cheap drug for self-medication.

Even yet, it had its ebbs and tides. From earlier days, there was a belief that aspirin might have ill effects on heart. But this belief has undergone a drastic change now. Aspirin is believed to be good for the heart.

The recent leading article appeared in the British Medical Journal says that all people who have just had a heart attack should receive aspirin and the clot-dissolving drug. Julian Desmond, Consultant Medical Director of the British Heart Foundation advised Physicians and the administrators to implement the new treatment.

Aspirin makes the heart grow stronger. Can 22071 physicians be wrong ? Many who took 325 milligramme of aspirin every day to determine whether they could reduce their risk of heart attack revealed that they have lowered their risk by almost half.

In the study organized by the Harvard University, half of the doctors took a placebo. Many suffered heart attacks and many were fatal. But among those who took aspirin over the four years of study had less number of heart attacks. Now it has become a practice even in numerous hotels to provide inmates with tablets of aspirin as a daily routine.

Every drug has its ill effects. Aspirin also is not an exception to this. Large excess of aspirin can lead to gastro-intestinal disorders followed by rectal bledding and peptic ulcers etc. Scientists warn the users of aspirin by saying that they should not use aspirin frequently without advice of the physicians.

USA researchers also confirm that aspirin which is a well-known drug as a killer of headache and neuralgic pain can also reduce incidence of heart attacks especially in people with cardiovascular disease. One aspirin tablet taken on alternate days can reduce risk of initial heart attacks dramatically by 47 per cent, these researchers reveal.

The benefits of clot-dissolving hearts in combination with aspirin are of such a magnitude these days that these can save many lives. British physicians concluded that a daily dose of aspirin to the extent of 325 milligramme for one month following an injection of streptokinase—the clot-dissolving drug can reduce the number of deaths by half within five weeks after attack.

Discovery of prostaglandins added fuel to the fire. It is revealed that if prostaglandins are some hormonal pain factor, aspirin may be considered as an anti-pain factor because aspirin can inhibit prostaglandin synthesis.

Although no exact mechanism as to how aspirin helps to combat heart diseases, the well-advanced theory is that aspirin when used in small doses can block manufacture of hormone—like chemicals such as prostaglandins which are capable of forming blood clots.

In view of overall advantageous position, some of adverse effects of aspirin were not regarded too much problematic till the recent days. But it is cautioned that too much use of aspirin can counteract the positive effects of its lower doses.

Aspirin, indeed, is the most used and the most abused amongst the synthetic drugs. Accumulation of high aspirin levels may be due to high doses used or its diminished metabolism in the liver with decreased renal excretion. Their combined effect or other factors may also be responsible for high aspirin levels.

Aspirin is a mitochondrial toxin. Many children were hypoglycaemic. Glucose infusion cannot correct hypoglycaemi. Aspirin is held responsible for the disease (called Reye's syndrome) in children. Many countries including India have restricted uses of aspirin in children below 12 years. In USA, however, it is below 16 years.

Even yet the benefits outweigh the misgivings. Aspirin holds promise to combat heart disease. But for that aspirin alone or the clot-dissolving drug streptokinase alone cannot be very much effective. Either can reduce death rate by about a quarter. But the combined effect is super-excellent, researchers say.

The golden opportunity lies with the nations where both aspirin and the clot-dissolving drugs are available. The developing nations cannot afford streptokinase on a massive scale as cost is high and is beyond reach of many.

It is estimated that in countries where both drugs are available, the number of lives that can be saved in the world might vary from sixty thousand to seventy thousand. Since with the change in life-style, the disease is rampant, treatment becomes imperative. Until recently, only clot-dissolving drugs were used. But the recent researchers have shown that efficacy of clot-dissolving drugs have gone up manyfold in the presence of aspirin. Not only soon, aspirin itself can lower risk factors by some extent.

This new property of aspirin is attributed as a good sign to the developing nations. Aspirin is cheap and readily available. It can be had from the natural sources. Synthetics are also available in the market. Developing countries like India, which cannot afford streptokinase can now take advantage of aspirin for saving many lives, the safe and the effective dose being 325 milligramme of aspirin according to the British Heart Foundation.

So inexpensive aspirin which can be had from Willow bark and now chemically synthesized is a useful drug especially for cardiovascular disease. It is non-toxic to many and is worthwhile only in mini doses. ☐

P. C. Bhattacharyya

An emerging galaxy

American astronomers recently discovered a gigantic slowly-rotating hydrogen cloud that they think is a primeval galaxy in the very early stages of formation, capable of forming planets and stars. Researchers at Cornell University in New York State and the Arecibo radiotelescope in Puerto Rico report that the discovery of the proto-galaxy shows for the first time that it is possible that galaxies are still being formed in the universe and were not produced only in some early epoch. The discovery could reshape the current view of the universe's history.

The standard model holds that galaxies were formed within a relatively short time after the so-called Big Bang that began the universe. All galaxies, each containing anywhere from 10,000 million to 100,000 million stars, formed from hydrogen clouds that gradually condensed to form planets and stars.

A proto-galaxy is a mass of hydrogen with few or on stars, yet big enough to form a galaxy when its hydrogen collapses under the call of gravity and, over millions of years, great masses of material clump together. The general belief has been that such formations halted thousands of millions of years ago.

The newly-discovered hydrogen cloud is elliptical, consisting of a diffuse envelope surrounding two large clumps of gas that may be merging. The giant cloud is rotating like a pinwheel, but so slowly that one revolution of its periphery would take about 10,000 million years—about the age of the universe !

The hydrogen cloud, relatively close in astronomical terms at 65 million light-years from Earth, provides astronomers an excellent opportunity to study galaxy formation. While the cloud has a diameter about ten times larger than that of our Milky Way galaxy, it is roughly one-tenth of the latter's mass.

Martha Haynes of Cornell as well as Riccardo Giovanelli of the Arecibo Radio Astronomy Group found the gas in the early part of 1989, using the 30-m radiotelescope of the United States National Astronomy and Ionosphere Centre in Puerto Rico. The two researchers discovered the proto-galaxy serendipitously while aiming the antenna at Arecibo at a supposedly blank patch of sky south of the Virgo cluster of galaxies to calibrate the instrument.

"Before stumbling onto this thing, neither I nor Haynes believed in the existence of such objects," Giovanelli admitted. "Other gaseous objects have been discovered before, but always closely associated with existing galaxies. However, this cloud seems to have formed independently, in a pocket of space isolated from other galaxies. Such isolation is the key to its significance."

Because the nearest galaxy is several million light-years away, Haynes said she believes the great spinning cloud is pristine matter surviving from the Big Bang and still possibly capable of creating stars. "Whether this cloud will remain the ghost of a galaxy, or will eventually shrink and begin to form stars, we don't know," Giovanelli stated. The discovery, he added, is in accord with other astronomical puzzles, such as recent findings that the way light from distant quasars is absorbed by intervening galaxies requires that the young galaxies be endowed with very large gaseous disks. This suggestion is conformed by the large size of the proto-galaxy discovered at Arecibo. □

Span

Debt for nature in Ecuador

Ecuador has had $ 9 million of its foreign debt fully converted to local-currency bonds for the acquisition and management of parks in the Andes, the Amazon and the Galapagos Islands. The sum exceeds all past United States debt-for-nature exchanges combined and represents the first time the full value of a debt will be applied to conservation. The World Wildlife Fund and the Nature Conservancy purchased the debt from US Banks for about $ 1 million ; the Missouri Botanical Garden paid $ 50,000 towards relieving the debt. Ecuador is one of the last strongholds for South America's only native bear, the endangered spectacled bear, and supports some 20,000 plant species, more than are found in all of North America. □

Bioscience

BOOK REVIEWS

The Wealth of India. Raw Materials. Vol.-2 : B—By Anon., pp. XLII+350+90, 90 Tables, XIV plates, 69 text figures, 1988. Published by Publications & Information Directorate, CSIR and printed at the Photocomposition-cum-Printing Unit, Hillside Road, New Delhi-110 012 Price : Rs. 220 ; $ 80.00 ; £ 45.00

In 1948, the Council of Scientific & Industrial Research (CSIR) embarked upon an amibitious project of preparing 'The Wealth of India' (WI). That project, a dictionary of Indian raw materials and industrial products, containing 11 volumes and two supplements, was brought to a successful conclusion in 1979 "Since the publication of the earlier volumes of the first edition of the Wealth of India, there has been a phenomenal progress in scientific research and surveys on India's natural resources, resulting in a vast accumulation of data. This fact, combined with the persistent demand for updated information from the users of this encyclopaedic work, made it imperative to bring out a revised and enlarged edition of Raw Materials Series." The revised edition, with Vol. I appearing in 1985 and Vol. II in 1988, seeks to make the information up-to-date and render WI more useful to laymen, students and research workers alike. As predicted by Jawaharlal Nehru, it "will be of great value to the builders of new India." His prediction has come true at last.

In writing this review, I had to consult the previous edition and was impressed with a series of striking changes in the revised edition. While Vol. I of the first edition embraced two alphabets (A-B), the exponential growth of information on Indian raw materials during the last four decades resulted in the creation of two parts for the revised version and one part is our concern for the moment. A scrutiny of Vol. 2B has revealed that the text matter covers 350 pages in contrast to 112 (under B) of the old edition. At present, there are 251 entries under the alphabet B as against 221 in the first edition. Side by side, there is a four-fold increase in the number of journals and a five-fold increase in the number of books cited for the revised volume. There has been a stupendous increase in the amount of material under four major articles : 8 to 26 pages for Bamboos ; 1½ to 20 pages for *Beta* ; 15 to 78 pages for *Brassica* ; 6 to 25 pages for Bees. Birds have been left out of the present treatise and warrant the publication of a comprehensive monographic article which would come out as a supplement to this volume, it is hoped, in the not-too-distant future.

The current volume includes seven items on minerals and 86 genera of plants. Whereas mineral and zoological entries have been arranged according to their common English names, the plant entries are set in the alphabetical sequence of their botanical names. There is an elaborate list of illustrations (plates and text-figures) ; this is followed by a list of books and periodicals referred to. The text-matter starts with *Baccaurea* Lour. (a genus evergreen trees from the Euphorbiaceae) and ends with *Byttneria* Loefl. (a genus of prickly climbers from the Sterculiaceae). The index has been divided into four categories : botanical names ; zoological names ; active principles and other important chemical compounds ; names in Indian languages, regional, trade and common English names. A significant innovation is the use index, comprising entries not only from Vol. 1A but also from Vol. 2B —an index expected to be worthwhile to persons engaged in industry in general and entrepreneurs in particular. The book has a simple get-up, printing being excellent and binding certainly sturdy.

The editorial staff deserve to be congratulated for their dedicated efforts and unstinted zeal for brining out this valuable compendium. Though the original Raw Material Series took more than 30 years to compile and the subsequent revisions would be a herculean task, the Publications and Information Directorate of CSIR should set up a time-frame by which they would be able to complete the work of revising all the volumes At the rate of three years per alphabet—the difference in time between the publication of Vols. 1A and 2B—the job would entail at least 72 years for the CSIR ! ☐

S. C. Datta

"International Journal of Quantum Chemistry : Quantum Chemistry Symposium No. 20" ; pp. 785+Table of Contents+Author Index ; (Editor-in-Chief) Per-Olov Lowdin, John Wiley, New York, 1986

This is the Proceedings of the International Symposium on Atomic, Molecular and Solid-State Theory, Scattering Problems, Many Body Phenomena and Computational Quantum Chemistry, which was held at Maryland, Florida, during March 10-15, 1986. Sixtyfour articles (invited lectures and contributed papers) authored by 122 contributors are the contents of this volume. Some of these fall outside the conventional domain of Quantum Chemistry but reflect the wide coverage of the symposium. Some of the topics covered are several aspects of Schröedinger equation and Hartee-Fock equation, relation of R-matrix to Titchmarsh-Weyl Theory, momentum space approach to relativistic atomic structure calculations, stability of conjugated hydrocarbon ions ; Graph theory in the study of metal cluster bonding topology, application of modified extended Huckel calculations to electronic structure, bonding and spectra of a binuclear platinum complex, impurities and defects in transition metals and their oxides, kinetic isotope effects for reactions of muonium atoms with F_2 and Cl_2, Electron distribution and chemical reactivity of molecules, transition metal-OH bonding, quantum chemical calculation of thermodynamic properties of acid-base equilibria is solution, mechanism of activation of coordinated olefins toward nucleophilic attack, some problems of chemical graph theory, collisional time-correlation function for molecular interaction, etc. This volume will be definitely useful to chemists with a theoretical bias and having interests in some of the specific topics covered.

Before these scientific articles there is the text (covering 7 pages) of some remarks by Harold Hanson, a Member of the US Government's Committee on Science and Technology. Although the opinion expressed here are in the US context, most of these are universally applicable and need serious consideration. Some of these are that the Federal Government must actively engage in providing adequate financial support to the Universities for both basic and applied research ; since nationally significant problems are cross-disciplinary, education policy should recognize that and funding should be available for cross-disciplinary proposals as well, and science is so vital to the whole world that it cannot be ignored even in diplomacy and in commerce. Surely these are good lessons for our Indian authorities as well.

D. Banerjea

SOME LEGENDS ABOUT NEWTON

N. K. MAITRA*

Some legendary statements are in vogue about ISAAC NEWTON.

1. "If I have seen further than others, it is only because I have stood on the shoulders of giants who have come before me."

The giants before him were unquestionably Copernicus (1473-1543), Kepler (1571-1630) and Galileo (1564-1642). But another equally brilliant personality was Tycho Brahe (1546-1601), though no law or hypothesis is associated with his name. He was more or less a highly skilled instrument maker for observing the movements of the heavenly bodies. He with his own invented instruments carried out remarkable observations of the movements of stars and planets collected data for more than twenty years, which paved the path for further astronomical studies and laws, though he himself did not enunciate any law. His mantle fell on Kepler, who is well-known for his three laws of planetary motion. In fact, Kepler joined Tycho Brahe's observatory for his scientific career.

On November 11, 1572, Tycho suddenly saw a "new" star around the constellation of CASSIOPEIA. It was called a "De Nova Stella," but later people named it as "Tycho's star".

2. "I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the sea-shore, and diverting myself now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me."

This saying has resemblance with the utterance.

"Humility is greater than pride."

3. Alexander Pope's couplet

"Nature and Newton's laws lay hid in night
God said, let Newton be ! all was light".

4. When his pet dog Diamond overturned a burning lamp, due to which many of his manuscripts, which were the product of the toil of years were burnt, he simply whispered, "Diamond, what have you wrought ?"

5. Another very common legend associated with Newton is the falling of an apple from the tree to the ground. One day, as Newton was sitting in his mother's garden at Woolsthorpe, he saw an apple fall from a tree. This set him thinking of the reason why it should fall straight down to the ground. Why, for example, did it not go upwards or sideways, instead of dropping perpendicularly to the ground. He came to the conclusion that

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the apple fell downwards, when the stem broke, because some force was pulling to the ground. Then he remembered the experiments of Galileo on the falling bodies, some of which Galileo had carried out from the leaning tower of Pisa. Incidentally, Galileo passed away in 1642, the year Newton was born. These thoughts ultimately led to the enunciation, which is known as Newton's Law of Universal gravitation.

According to this law, the force of attraction F between two particles is proportional to the product of their masses m_1 and m_2, divided by the square of the distance r between them.

$F = g \frac{m_1 m_2}{r^2}$ where 'g' is the gravitational constant.

Its value in the F.P.S. system in our earth is 32 ft/sec^2 in the C.G.S. system it is 981 dynes/sec^2 and in the M.K.S. system it is 6.672×10^{11} cubic metres per kilogram per second per second ($M^3 Kg^{-1} S^{-2}$).

The Law of gravitation is sometimes also called the Inverse Square Law, because it follows the above mathematical relation.

The main significance and importance of this law,—is that not only a massive body is attracting a tiny body, the tiny body also attracts the massive body,—although its effect is insignificant and every particle, massive or tiny is attracting all other particles.

In 1785, Coulomb discovered another law from the behaviour of charged electrical particles, which also follow the inverse square law.

The magnitude of the electrical Force E is given by the relation.

$E = \frac{b_1 b_2}{i\, r^2}$ Where b_1 and b_2—are the quantity of the charges of the two particles.

r—distance between them

i—constant of proportionality

There is however, one fundamental difference. According to Newton's law gravitational force is always attractive. The electric force can however be both attractive and repulsive. Charges of the same kind (both positive or both negative) repel each other, while opposite charges attract each other. Similar is the case with the magnetic forces between charges, which obey the inverse square law. We know that like poles repel, unlike poles attract.

It is mentioned here casually that while considering the behaviour of sub-atomic particles, besides the gravitational force and electromagnetic force two other forces also play. They are strong and weak nuclear forces.

To honour Newton's contribution to Mechanics,—a new unit of force is named after him. In the S.I. unit it is termed as Newton. This is defined as the force needed to accelerate an object with a mass of one Kg by one metre per second per second.

1 Newton equals to 10^5 dynes.

The scientist Edmund Halley had a great role to play to bring Newton in the limelight. It is probably not an exaggerated statement but for Halley, Newton probably would have remained an obscure person. Halley is famous for his discovery of a comet, which goes by his name, but Newton was also his another stupendous discovery.

Newton did not like any controversy with his scientific findings and what he published. But his life, however was not always in his dreamland of science. He had rivals. One such person was Robert Hooke. He occasionally claimed that he made prior discoveries of some which Newton had accomplished including the law of gravitation and his other discoveries and enunciations in the fields of Mechanics and Optics. Robert Hooke was brilliant, but not of Newton's calibre. He was Newton's contemporary, and was somewhat eclipsed by Newton. If he were born in another generation, he certainly would have a more dominating influence in the academic world.

Newtons invented Calculus. The German mathematician Leibnitz also claimed the same. Leibnitz's friends vigorously championed and supported him. Newton felt sad and remained mentally disturbed. Today, probably, we think that both these savants invented the subject at the same period, but both being unware what the other was doing.

Years have rolled by. There is no point in discussing to whom the credit goes for the inventions and discoveries. Only when we read their contributions we fell elated and we are glad to know that these luminaries lived and toiled hard to find beauty and order in the Nature, and tried to explain her secrets.

The above two controversies made Newton somewhat depressed and he became more or less an introvert. Not that he stopped his scientific investigations, but he did not publish his findings and noted down the results in his note-books and kept them in the drawers of his writing table.

One day in 1684, Edmund Halley put forward a difficult mathematical problem. Newton gave the answer quickly. Halley was amazed. He asked Newton how could he give the answer so quickly. Newton told that he has been working on these problems for years together. Newton opened a large drawer and pulled out great mass of papers, which contained the calculations.

Halley was amazed, and asked his friend what prevented him in publishing them.

Newton replied in a calm voice. "I have already blamed my own imprudence in the past for parting with so substantial a blessing as my quiet to run after a shadow."

Halley heard his friend's utterance and asked him to hand over the bundle of manuscripts. Newton wanted to remain in seculusion. Halley approached the Royal Society for financial help, but the learned body refused to do so. Ironically, Newton was the president of the Royal Society for twenty four years 1703-1727. Halley was not cowed down. Halley at his own expense, brought out a nice book in 1687, containing Newton's work, which is probably one of the greatest scientific books ever written. The first edition of the book was like this.

PHILOSOPHIAE
NATURALIS
PRINCIPIA
MATHEMATICA
AUTORE: I.S. NEWTON
JULII, 5, 1686

Posterity has remembered Halley certainly by the discovery of the comet which goes by his name but he also put forth before the world the findings a great luminary—Isaac Newton, and the world can thank him equally for this unselfish work, which is a rare incident. Amidst the turmoils of the world, there are persons who do not lose sight of human heritage. □

Letters to the editor

Population dynamics of *Aphis gossypii* Glover on okra, West Bengal : Key factor analysis

Aphis gossypii Glover is well known to infest okra (*Abelmoschus esculentus* L.) in different states of India[3,13,18] and causes yield loss that varies in different agro-climatic regions[7], *A. gossypii* Gl., a polyphagous aphid, feeds on a number of crops throughout the year in Bengal under the influence of varied bioclimatic factors for population build up and abundance. A detailed account of the same appears to be a prerequisite for pest forecasting and population modelling on the concerned crop and that can only be made through seasonal observation. The available information on the incidence of *A. gossypii* Gl., on okra are rather limited[10,14]. Hence, the present work has been undertaken at Midnapore district of West Bengal to analyse the crop-climate impact on the population dynamics of *A. gossypii* Gl., on okra.

In a plot (2.5 m × 2.5 m) in Midnapore district (West Bengal) 20 plants of okra (cv. Pusa swoani) were planted during mid-November and mid-February in Rabi (1986-87) and Kharif (1987) seasons respectively. Common agronomic practices were followed[1] for raising the crop. Aphid incidence were recorded[17] on three randomly selected leaves (old, young and tender) per plant at weekly interval from sowing to its harvest. Meteorological factors were recorded during the period of observation. Several population parameters (population index $I = \frac{Pn+1}{Pn}$ and population growth rate $rN = \frac{dN}{dt}$) were used to analyse the key factors responsible for aphid abundance[8,11,14,15].

Aphis gossypii Glover was found to prevail on okra from early December to late February (rabi) and from early March to late May (Kharif) (Table 1). Climax incidence of its population could be seen during the 1st week of January (rabi) and last week of May (Kharif) at the crop age of 6 weeks in rabi and 5 weeks in Kharif when each leaf harboured 39.09 (rabi) and 55.26 (Kharif) aphid individuals. The climax incidence was followed by an abrupt decline and then it continued with minimum population up to its harvest saving a short periodic disappearance of the same during Kharif. During peak incidence, 75% (Kharif)—80% (rabi) plants and 56.66% (Kharif)—78.33% (rabi) leaves were found to be infested by the aphids.

Physical features (Table 2), during aphid incidence, were as follows :

Rabi	—Temperature	18°C—24°C
	RH	62 – 71%
Kharif	—Temperature	27 – 34°C
	RH	65 85%

Interestingly, it could be found that during population abundance temperatue (18°C in rabi and 27°C in Kharif) was relatively low and relative humidity (68% in rabi and 82% in Kharif) was high in both the seasons. As there was rainfall only during Kharif, impact of the same on the population abundance could not be compared. Of the Climatic factors (Table 3) temperature was seen to correlate negatively while relative humidity appeared in positive correlation with respect to several population parameters of aphids and the same were true for both the seasons.

TABLE 1 : Population attributes of *Aphis gossypii* Glover on okra crop in rabi (1986-87) and kharif (1987)

Date	Crop attributes				Population attributes		
	Age in weeks	Infested plants %	Infested leaf %	Insect/ leaf	Incidence %	Population Index $I=\frac{Pn+1}{Pn}$	Growth rate $rN=\frac{dN}{dt}$
				RABI			
D_1	2	15.00	13.33	2.67	0.27	0.00	0.00
D_2	3	50.00	43.33	8.31	2.44	2.19	1.03
D_3	4	55.00	65.00	20.78	12.67	3 84	1 92
D_4	5	80.00	78.33	28.04	14.88	4.01	1.30
J_1	6	75.00	76.66	39.09	25.16	4 53	1.13
J_2	7	70.00	71.66	11.85	7.36	3.30	0 66
J_3	8	55.00	63.33	7.42	4 53	2.84	0.47
J_4	9	45.00	30.00	9.72	3.95	2 68	0.38
F_1	10	35 00	35.00	13.19	6.85	3.23	0.40
F_2	11	35.00	38.33	20.41	8.14	3.62	0.23
F_3	12	20.00	21.66	15.23	8.26	3.42	0.12
F_4	13	20.00	11.55	7.92	3.49	1.55	0 05
				KHARIF			
M_1	2	10.00	3.33	2.50	0.17	0.00	0.00
M_2	3	15.00	8.33	2.40	0.42	0.87	0.43
M_3	4	30.00	25.55	6.00	3 14	2.89	0.96
M_4	5	75.00	56.66	55.26	65.54	5.93	1.48
A_1	6	60.00	53.33	24.44	27.27	5.05	1.01
A_2	7	50.00	38.33	2.83	2.27	2.56	0.41
A_3	8	35.00	15.00	2.11	0.66	1.33	0.19
A_4	9	0	0	0	0.22	0.69	0 09
M_1	10	0	0	0	(0.03)	(0.01)	(0.01)
M_2	11	10.00	3.33	2.00	(0.03)	(0.01)	(0.01)
M_3	12	10.00	3.33	2.50	0.07	0.09	0 02
M_4	13	10.00	6.66	3.00	0.17	0.87	0.07

*Figures in parenthesis are the converted values in Zero marks.

TABLE 2 : Showing the physical features (temperature and relative humidity (%) during aphid incidence

Rabi			Kharif (1987)		
Time (Months)	Temperature (°C)	R. H. (%)	Time (Months)	Temperature (°C)	R. H. (%)
D_1	23	71	M_1	30	75
D_2	21	70	M_2	30	65
D_3	22	71	M_3	28	77
D_4	21	70	M_4	27	82
J_1	18	68	A_1	30	76
J_2	19	66	A_2	34	67
J_3	21	66	A_3	33	76
J_4	20	67	A_4	32	78
F_1	20	66	M_1	32	74
F_2	21	64	M_2	32	79
F_3	22	63	M_3	31	82
F_4	24	62	M_4	29	85

TABLE 3 : Budget table showing key values (b-values) (Converted regression co-efficient)

Aphid attributes	Temperature	Relative humidity	Age
	Rabi		
Aphid incidence %	0.093	0.065	-0.323
Population index	—0.072	0.067	—0.958
Rate of population increase	—0.291	0 995	—1.253
	Kharif		
Aphid incidence %	—0.115	0.287	—0.914
Population index	—0.048	1.273	—0.837
Rate of population increase	—0.817	1.653	—1.323

Furthermore, crop age was seen to show negative correlation in both the seasons.

It is thus evident that *Aphis gossypii* appears on okra from its seedling stage and attains peak during tender age. The feature is true for both the seasons. The bioclimatic index values (b)/(regression Co-efficient) indicate that low temperature and high relative humidity appear to favour population growth of aphid on the referred crop. This feature corroborates well with the tenderness of the host age. However, it is apparent that aphid susceptibility in Kharif crop appears to be very prominent though the prevailing weather factors during the season are much higher than in rabi. This may be due to the prolonged total nymphal duration, reproductive and post-reproductive period of an adult that shortens the rate of reproduction through not very markedly in lower temperature[5] and reverse in higher temperature. Again, irrespective of weather factors, aphid performance appears to be in greater amount in tender plants in both the seasons indicating a preferential response of the aphid on the crop age. Moreover, the approximation of regression co-efficient values (b) towards 1.0 in favour of tenderness of the crop age implies further consideration on key factor for compensation[8] in population build up of aphid.

Hence, the effect of weather factors on aphid population is in conformity with the earlier findings [4, 6, 18]. Nevertheless, host age discrimination deserves to be one of the leading factors in population trend of the aphid on the concerned crop. This assumption is in agreement with the earlier findings [2, 9, 10, 12, 19].

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Received : 2 September, 1988.
Revised ; 8 September, 1989.

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On the 'fast-growing fry' of cultivated carps

When a batch of fish spawn obtained from a particular pair of parants and grown in ponds, a small percentage of these fry markedly outgrew the rest. Such faster growing fry are called 'shoot fry' and they are known to occur in the case of Indian as well as Chinese carps[1]. The present paper deals with a preliminary observation on the survival, growth and production of rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigala*) and scale carp (*Cyprinus carpio* var. *communis*).

The first part of the experiment was conducted in PVC pools. About ten days before the expected date of stocking the fish spawn, all the pools were manured with appropriate doses[2] of cowdung, G.O.C., triple superphosphate and lime. Live *Moina* (@ 1 per 2 lit. of water) was inoculated in each pool 3 days after manuring. After that also, manuring was repeated at half of the above doses every alternate day. Moreover, prior to releasing the spawn, the density of plankton in each pool was checked and if it was found less than 2500 per litre, fresh planktons were added from a neighbouring pond. Now, about 50,000 spawns of rohu, procured from an induced breeding centre were distributed equally in each pool. On the 16th day after stocking, harvesting of fry from each pool was done, noting the number survived. Shoot fries were segregated from each pool and pooled them together for further growth. The spawns of mrigal and common carp were also reared in a similar way. However, all the three species are not reared simultaneously.

The nursery ponds used for rearing the fry were seasonal ponds. Because of acidic nature of the soil in this region[3] lime @ 500 kg/ha was applied to rectify the pH of the pond water. Besides, cowdung @ 10,000 kg/ha was also applied for planktonic growth. The pH of water prior to stocking was found to range between 7.03 to 7.20. The same nursery pond was used to rear both sets (normal and shoot) of fry. For this, each pond was partitioned in the middle by fine wire meshed net so that the two sets of fry remained separated from each other, but water along with nutrients could freely pass from one compartment to the other. The stocking number of normal and shoot fry was identical in each species and no artificial food was given to them. However, periodical checking of the density of plankton was made and if required, fresh plankton were added (so that the density never fall below 4000 per litre) as described earlier. After 3 months, the survival, growth and production of the normal and shoot fry were recorded. The salient results are as follows.

The percentage survival of the spawn of rohu, mrigal and scale carp was found to be 84.1, 74.8 and 89.0 respectively (Table 1).

TABLE 1 : Survival and growth of fish spawn in the first 15 days of rearing in PVC Pools

	Rohu	Mrigal	Common carp
Total number of stocking	50,000 (approx.) spawn of each species		
Age of the spawn when stocked	3 days	3 days	5 days
Percentage of survival	84.1	74.8	89.0
Total number of shoot fry appeared	1,559	1,375	2,523
Percentage of shoot fry	3.71	3.68	5.67
Ave. growth of normal fry L (mm)	19	16	18
W (gm)	0.21	0.19	0.22
Ave. growth of shoot fry L (mm)	31	26	31
W (gm)	0.36	0.32	0.41

TABLE 2 : **Survival, growth and production of shoot (S) & normal (N) fry in nursery pond**

	Rohu		Mrigal		Common carp	
	N	S	N	S	N	S
Stocking density	4,000 fry (@ 50,000/ha) were stocked in each pond (i.e., the number of normal & shoot fry being 2,000 each)					
P. C. of survival	73.1	85.8	63.5	79.3	79.1	96.2
Ave. growth after 90 days of rearing Length (mm)	96	118	87	103	94	147
Weight (gm)	9.8	16.3	8.5	11.6	9 6	27.3
Gross production (kg/ha/3 months)	380.64	699.27	269.88	459.94	379 68	1313.13

However, the p.c. of the shoot fry appeared was very meagre and constituted only 3 71, 3.68 and 5.67 of total surviving fries of rohu, mrigal and scale carp respectively. Biswas and Phukon[4] in earlier experiments of *Labeo* sps. also reported scanty number of shoot fries in these species. The data presented in Table 2 reveals that the shoot fry of all the three species not only shows better survivality, but also exhibit better growth. Furthermore, preliminary observation reveals that the shoot fries are having higher gastro-somatic indices than those of the normal fries[5]. Larger fishes are reported to be grown faster because they prove to be more efficient in competition and able to attain more food than the smaller ones[6].

The production data of the two sets of fries shows that the net yield of the shoot fry is significantly higher than that of the normal fry in all the three species studied (Table 2). The size of the fish supposed to be an important factor which affects the growth of the population and production also significantly improved[7].

The authors are grateful to D.S.T., Govt of India for financial assistance.

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Received : 13 September, 1988.
Revised : 1 November, 1989.

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Introduction and establishment of *Neochetina eichhorniae* and *N. bruchi* on water hyacinth in Loktak lake, Manipur

About 75% of the area of the 286 sq. km. Loktak lake in Manipur (518 sq. km. at flood level) is infested by water hyacinth (*Eichhornia crassipes*). The Loktak multi-purpose project, which was completed in June 1983, has a capacity to generate 105 MW of power to cater to the needs of Manipur, Assam and Nagaland and for irrigating 23,000 ha of land, besides being used for fisheries. Since water hyacinth, which reproduces sexually and by vegetative means, is capable of doubling in biomass every 10 days and can cover up the entre water surface[1], it poses a major threat to the economic development of this region.

Water hyacinth, which is reported to have made its entry into India before 1900, is the most serious aquatic weed in the country creating a large number of problems in the utilisation and management of fresh water resources[2]. Manual, mechanical and chemical methods of control are far from satisfaction, besides being expensive, as repeated applications are often needed[3]. Successful biological control of this weed occurring in and around Bangalore, through the introduction of the weevils *Neochetina eichhorniae* Warner and *N. bruchi* Hustache (Coleoptera : Curculionidae), is on record[4,5].

During the first week of May 1987 the senior author visited Loktak lake at the request of the Chief Engineer, National Hydroelectric Power Corporation and released 3500 adults of *N. eichhorniae* and 1500 *N. bruchi* in the Thanga village area. Subsequently 1500 adults of *N. eichhorniae* and 1000 *N. bruchi* were despatched from Bangalore by air-freight. These insects were released at the power channel mouth.

Adults of the weevils scrape and feed on water hyacinth leaves, leaving characteristic feeding punctures. The females deposit their eggs below the epidermis of the petioles and laminae. *N. eichhorniae* and *N. bruchi* adults survive for 142.2 and 134.2 days respectively and lay 891 (150-1254) and 681.6 (303-918) eggs[6]. The larvae which hatch out after 7-14 days tunnel inside the petioles and after attaining full growth emerge and pupate under water attached to living roots of water hyacinth. Larval and pupal periods were completed in 75-90 and 14-20 days respectively[7].

N. eichhorniae and *N. bruchi* established readily in the Loktak Lake. During the last week of August 1988, about 15 months after releases were initiated, it was observed by the senior author that the insect population had built up in more than 1 sq. km. area at each of the release sites although releases were carried out in less than 1 ha area at each site. All the water hyacinth plants in these areas had moderate to heavy adult feeding punctures on the leaves. In the Thanga village area up to 4 adults (mean 2.3) could be collected per plant. Damages caused by larval tunneling could be made out on the petioles and also within the rhizomes.

The population density of the weevils was found to be higher at the lake mouth where up to 6 adults could be collected per plant (mean 3.5). Water hyacinth plants along both banks of the power channel were stunted in growth due to heavy feeding by adults and larvae.

The weevils were also observed to have dispersed over a very large area in the Loktak lake. Thus, signs of insect activity, as evidenced by adult feeding punctures on leaf laminae, could be detected all along the more than 5 km route from Moirang to Thanga. However, population densities of adults were much lower (0.05 to 0.5/plant) compared to the initial release sites About 10,000 more weevils (7000 *N. eichhorniae* and 3000 *N. bruchi*) were released along the same route in areas where insect population density was very low.

The results of the studies carried out so far clearly show that the climatic conditions in Manipur are suitable for insect growth and multiplication. The original release population of 7500 adults have increased over a millionfold within 15 months and is expected to disperse throughout the lake and build up in the next 6 to 12 months. The chances of control of water hyacinth in the Loktak lake thus appear very bright. Releases of *N. eichhorniae* and *N. bruchi* therefore offers potential for control of water hyacinth in the entire north-eastern region of India, where it is considered to be a serious problem.

The authors are grateful to Dr. R. M. Pandey and Dr. T. R. Subramanian, the present and former Director, I. I. H. R., Bangalore and to Col. N. P. K. Nambiar, Chief Engineer, NHPC for encouragement. The assistance provided by Mr. N. Chandrasekhara in multiplication and collection of weevils is also acknowledged.

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Received 12 October, 1988.

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Influence of garden-cress seeds on the catecholamine concentration of the rat adrenal medulla

Garden cress seeds (*Lipidium Sativum* Linn) do not belong to the group of common food stuff, but these are cultivated as a salad plant throughout India, specially in 24-Parganas, Hooghly, Bankura, Midnapur, Birbhum and Howrah. In Hindi and Bengali language, these seeds are called 'Halim'[1]. The seeds have a lot of medicinal properties such as rubefacient, galactogogue, laxative, tonic, aphrodisic and diuretic[2]. These are also used in the treatment of diarrhoea, respiratory troubles, cough and piles in the Punjab. The seeds are widely used by Unani medical practitioners.

Chemical analysis also showed that the seeds contain an alkaloid (0.19%), glucotropoetin, sivapan, sivapic acid and uric (0.108 g/kg). On steam-distillation, they yield an oil which has pronounced oestrogenic activity and showed better development of ovaries in the experimental rats[2]. The high-iron content of garden-cress seeds influence haemoglobin level of blood and causes significant increase. Hence, it indicates that these seeds may have a role in curing and preventing iron-deficiency anaemia.[3]

It has also been reported that the administration of cress seeds cause undesirable side-effects, such as polydepsia, excessive sweating, hyperthermic feelings and flushing in face, etc. But what is the actual physiological cause of these side effects are still not known. It may be assumed that some of these effects are due to endocrine factors. Hence, we have selected adrenal glands because adrenal glands are concerned with metabolic and emotional adjustments and blood-pressure changes. The aim of our present study is to observe whether garden-cress seeds have any effect on histological as well as hormonal concentration of adrenal glands.

Adult albino rats of average body weight 140 gm were taken and maintained on a stock ration for one week before being put on to the experimental diets. The rats were individually caged and divided into two groups. One group was given 20 gm of normal stock diet, while the other groups were given 20 gm mixed diet containing 50% seed powder. The animals were given free access to fresh tap water. Daily food intake, initial and final body weight and body temperature of each rat were recorded. The feeding of the experimental diets was continued over a period of eight days, after which the animals were killed with ether anesthesia. The glands were removed immediately after autopsy and treated with chromate-dichromate and iodate solution for the detection of total catechol hormones and noradrenaline secreting cells respectively[4]. There was no changes in the body weight between the initial and final record of control and treated groups.

The difference between the initial and final body temperature of treated animal was slightly higher than that of the control rats. By measuring daily residual diet of each rat, it was found that average daily food consumption throughout the experimental period of the control group was slightly higher than that of the treated group.

Histochemical observation (Table 1):

(a) Chromate-Dichromate :

Control : The whole of the adrenal medulla showed a positive reaction. The medulla was stained yellowish brown with deeper stained patches of small size found to be distributed throughout the medulla. Granules were present in the deeper stained patches. The medullary strands in shape were fairly large.

Treated : Although the medulla was also been stained yellowish brown, the colour intensity was deeper compared to the control. Isolated darker patches present in glands were also deeper compared to the control. The size of the patches were also larger.

The sinusoids were round or oval in shape. The medullary strands appeared to be compact in appearance.

TABLE 1 : Visual observation on the concentration of the cytochemical components in adrenal medulla

Group	Chromate Dicromate	Iodate
Control	2+	2+
Treated	4+	4+

4+ = Very intense
2+ = Moderate

(b) Iodate :

Control : The iodate reaction, positive for noradrenaline was indicated by the presence of small isolated dark patches, in a light yellowish coloured homogeneous cellular matrix Patches were found to be distributed mostly towards the periphery of the medulla, while the fewer number were distributed uniformly throughout the medulla. The strands were oriented in a compact manner. Larger and regular sinusoids are distributed uniformly throughout the medulla.

Treated : The intensity of the iodate reaction of the isolated patches in the treated group was found to be greater in the glands. Size of the patches were found to be distributed mostly towards the periphery of the medulla.

In our present study, histochemical observations show an interesting change. Chromate-dichromate positive patches in the adrenal medulla of treated are deeper and larger compared to the control. This change may indicate increased synthesis of catecholamins. Iodate-positive patches in the adrenal medulla of treated are also deeper and larger compared to the control. This change also may indicate increased synthesis of noradrenaline. But whether cress seeds stimulate the release of catecholamines is yet to be investigated by further studies.

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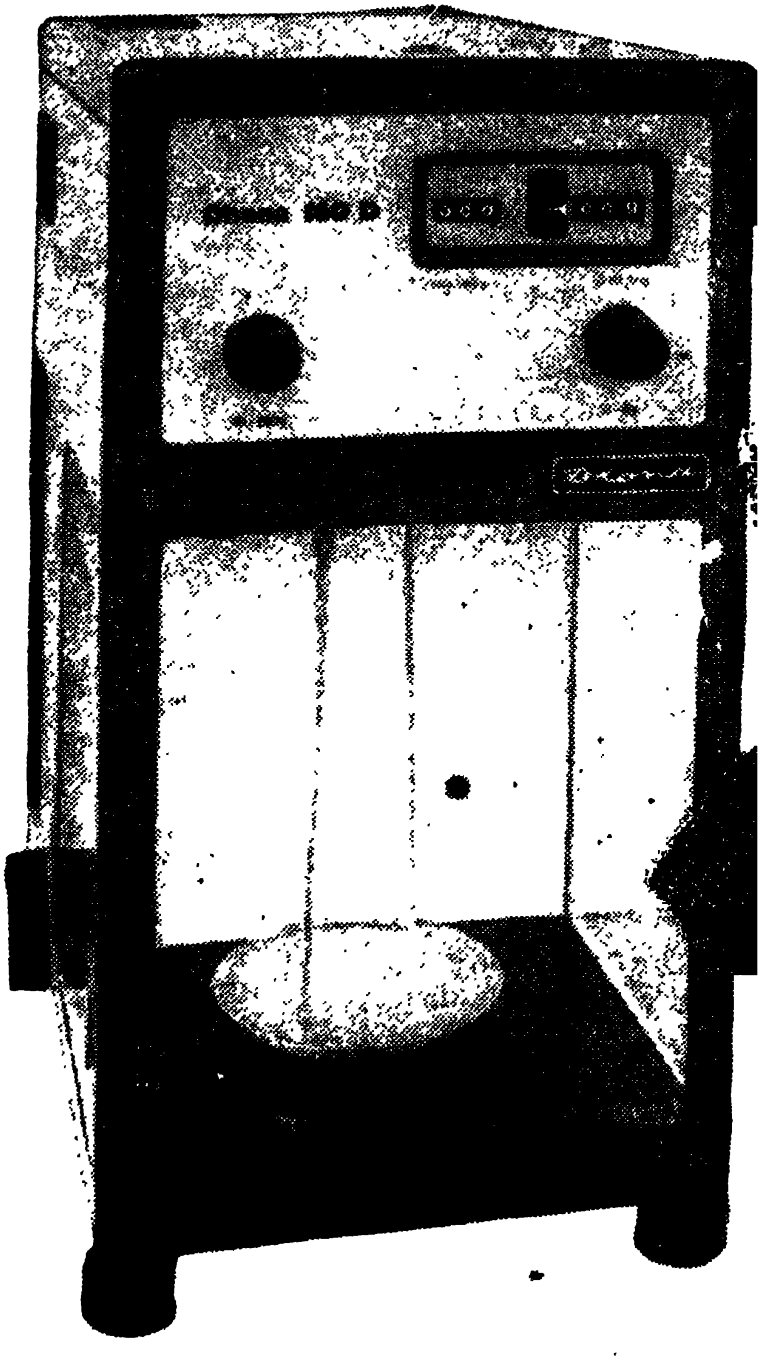

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